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LOUIS KOSSUTH.

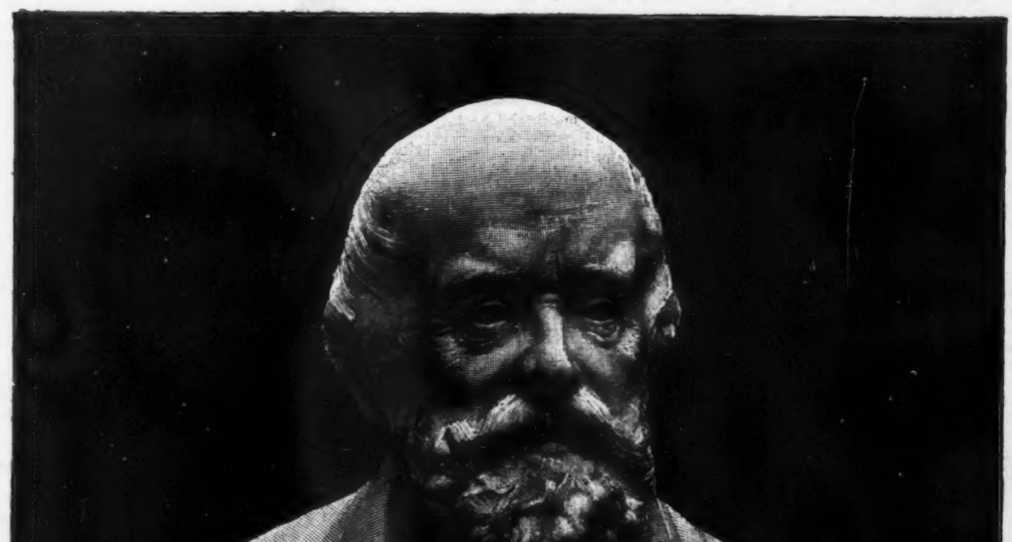
LOUIS KOSSUTH was the oldest statesman of our times, for he was almost ninety-two years old when he died, on March 20, in Turin, where he had lived for many years. Until quite recently he had led an active life, working diligently on the four volumes of his reminiscences, which he published under the title, "Meine Schriften aus der Emigration," in Hungarian, German, and English.

The independent parties looked upon him as their real leader, and the chiefs often turned to the old "ex-dictator" when there were difficult or critical questions to be settled. The numerous long papers that he wrote on political subjects revealed the wonderful vigor of his mind, and also the enthusiasm and liberality with which this remarkable old man still thought and spoke on the subjects that had stirred him in his youth. In this respect he reminds one of Alexander von Humboldt, who, when ninety years old, was intensely interested in the progress of the political as well as of the religious world.

Kossuth corresponded with many famous statesmen, savants, and authors, and has left a wealth of interesting letters, which, it is to be hoped, will be published. When on his death bed he gave to his country his valuable library, which contains much that will be very important in writing the history of the nineteenth century.

During his unexpectedly long life Kossuth remained true to a sentiment that he expressed in a letter written from London after the treaty of Villafranca: "The blessing of success remains with God; man can only endeavor sincerely to do his duty."

We publish herewith an engraving, for which we are indebted to our honored contemporary the *Illustrirte Zeitung*.



LOUIS KOSSUTH.

THE ART OF READING BOOKS.*

By J. E. C. WELLDON.

THE cities and parishes which have taken advantage of the Public Libraries Act seem to me to have been wise in their generation. They have understood the civilizing and refining power of literature. They have seen in it the antidote, or one of the antidotes, against what is mean and materialistic in modern life. It is related by the historian Diodorus Siculus that over the doors of the great Egyptian Library of Osymandyas—the king who gave his name, as you may remember, to Shelley's sonnet—were inscribed the Greek words ψυχῆς ἰατρεῖον, which mean "the sanatorium of the soul." For the soul may be valetudinarian like the body; and, like the body, it has need of a bracing discipline. You can never cure any human ill by preaching against it; you must supplant it by some wholesome vital influence. The "expulsive power of a new affection," as Cardinal Newman has called it in one of his sermons, is the only means of driving out old affections. No doubt he was thinking of religion, and he meant that one religious faith can be eradicated only by another; it is proof against mere denial. But one taste or habit also yields only to another; it is not destroyed, but supplanted. And if you would draw men away from the public house or the "bucket shop," and from such associations as are congenial to these places, you must awaken in them higher tastes and aspirations, and of these the love of reading is the chief. May I commend to you a passage taken from a book which is not so popular nowadays as it was once, Burton's "Anatomy of Melancholy"? You know he treats first of the causes of melancholy among men, and then of its cure. He says: "So sweet is the delight of study, the more learning they have (as he that hath a dropsy, the more he drinks the thirstier he is), the more they covet to learn, and the last day is *prioris discipulus*," and then he relates the following story, which is worth remembering: "Heinsius, the keeper of the library at Leyden, in Holland, was mewed up in it all the year long; and that, which to my thinking would have bred a loathing, caused in him a greater liking. 'I no sooner (saith he) come into the library but I bolt the door to me, excluding lust, ambition, avarice and all such vices, whose name is idleness, the mother of ignorance and melancholy herself, and in the very lap of eternity, among so many divine souls, I take my seat with so lofty a spirit and sweet content that I pity all our great ones and rich ones that know not this happiness.'"

It would be unsafe, perhaps, to predict that many who hear me will use this library in the spirit of Heinsius. But the love of books is one of the greatest blessings in life. Only you cannot love a book all at once; with books, as with men and women, love is the privilege of long intimacy. It is only when books have been read and reread, and, as it were, clasped to the heart, that they become, in Macaulay's words, "the old friends who are never seen with new faces; who are the same in wealth and in poverty, in glory and in obscurity." To know even one book in this way is to gain a spiritual revelation. It is thus that the study of the Bible, even as literature, has so profoundly affected English life and thought; for it often seems to me that the most sharply drawn of all dividing lines in English history is between reading and non-reading England, or, in other words, between England without the Bible and England with it. Our forefathers were contented with one book; we are sometimes not contented with many.

Gibbon says, in his autobiography, that he would not "exchange his early and invincible love of reading for the treasures of India." But modern education has so far equalized the social classes of the community that the pleasure of reading, which at the beginning of this century was enjoyed by a small cultivated minority, has already become, or is fast becoming, the boon of all.

Did it ever occur to you to realize what a change the universality of reading and writing, which has only come to be true since the Education Act of 1870, has made in the English-speaking world? It is not the only change which distinguishes the nineteenth century from all the preceding centuries; for I suppose (to take one example) there is no reflection more curious than that the means of locomotion should have remained practically the same from the time of the Pharaohs until the reign of King George the Fourth, and then should have been revolutionized in a day. But fifty years ago a girl who left her village in the country for domestic service was cut off from her home, her family, and all the associations of her past life; she could not write to her parents, nor they to her; and if they did write, or get somebody to write for them, it was impossible for her to read their letter; she might be ill, she might be ruined, she might be dead, and the probability was that nobody who felt a natural interest in her story would know anything about her.

How different it all is now, when, by the gentle arts of reading and writing, and especially of photography, that beneficent means of keeping the memory of our

* An address delivered on January 4 at the opening of the Kilburn Public Library.

absent friends and children alive within our hearts, there is not an incident of her life, wherever she may be, but it is familiarly known to all the members of her family! Dreary, indeed, was the old age of the poor fifty years ago, without books, without newspapers, without any broadening interests. But to-day, even where the parents cannot read, their children are their interpreters of human things, and whatever pain the parents may feel, as is not unnatural, in the consciousness of their own inferiority, is more than compensated by their honest pride in their children's culture.

You, ladies and gentlemen, to whom this library will offer in future the resources of its many thousand volumes, will all be readers; and I do not see how I can better utilize the few minutes in which I have the honor of addressing you than by trying to give you such advice as will help you to read wisely. For most of those who employ this library will not be students; they will not have unlimited time for reading books; it is, perhaps, only for a brief hour, when the toil of the day is done, that they will think of getting literary information. Sydney Smith said once: "Live always in the best company when you read. No one in youth thinks on the value of time. Do you ever reflect how you pass your life? If you live to seventy-two, which I hope you may, your life is spent in the following manner: An hour a day is three years; this makes twenty-seven years sleeping, nine years dressing, nine years at table, six years playing with children, nine years walking, drawing and visiting, six years shopping and three years quarreling."

It may be permitted me to hope that you will not spend your life—at least the ladies will not—altogether in this way, partly because you will enjoy the benefits, moral as well as intellectual, of this library. Yet, however economical of your time you may be, it will be a practical difficulty for you or for any one in the present day to cope with the vast and ever-increasing mass of literature. It is perhaps three thousand years since the invention or use of writing, and during that time the writers of many nations and many ages have been pouring out books, until the stream of literature has swollen into a cataract—a very Niagara of books—which sweeps or threatens to sweep away the delights of civilization before it. The reader of to-day aspires to know something of the thoughts which the wisest of men in all the periods of history have expressed upon the most vital subjects of human interest. He cannot, therefore, acquiesce in narrow reading. He must read widely, not in English only, but in many languages, or in translations from them. He must cultivate a cosmopolitan literary spirit. But life is short; and alas! art is long and is becoming longer; the number of books which a busy man can read in a year can hardly at the most exceed fifty; and, considering what a strain is now put on the most absorbing literary appetite, I am at a loss to see how any man who lives at the end of the twentieth century will deserve to be called educated at all. For books do not become shorter as they become more numerous, it rather seems that they increase in bulk and volume; for Gibbon wrote the history of the "Decline and Fall of the Roman Empire," a period of fifteen hundred years, in eight octavo volumes, and a living historian occupies the same number of volumes with the history of less than thirty years in England alone.

In these circumstances, looking to the accumulating mass of ancient literature, and the ever-accumulating mass of literature which is new, busy men have hit upon various methods of arriving by a kind of short-cut at literary knowledge. One method has been to choose an arbitrary number of the best books, and to concentrate attention upon them. Sir John Lubbock is, I think, responsible for the original list of the hundred books which are most widely approved, and he, if any one, is competent to make the selection; but the number has been found too large, or it has not been always accepted, and so it has been reduced by various authorities until it has come to be supposed that there is no difficulty in determining a number, however small, of the best books in the world, and I remember that a lady wrote to me not long ago asking me to name the *three* best books, exclusive of the Bible. Then, again, it has been thought possible to acquire an insight into literature by selections or extracts from famous books, or by abridgments of them. It sometimes happens that a person reads a review of a book and imagines he has done as much as if he had read the book itself. But upon the whole I would venture to give you a serious warning against all extracts and abridgments, whatever they may be. The author of a book has a right to demand that, if it is read, it should be read as he wrote it; it is not the same book when it is cut up or boiled down. And as to reviews, they are not the book at all; they are no more the book than a man's clothes are the man himself; and, if you have ever written a book and seen it reviewed, it is only too likely that you have experienced a sense of astonishment at observing that, though you may not have possessed a complete knowledge of the subject with which it deals, yet at least you knew more than the reviewer.

There is an art of reading, I think, as well as an art of writing. It is not enough that people should be told to read; they must be told how they ought to read, and what. For in all life it is not the work which men have to do that makes the difference, it is the way in which they do it. A man may do little or nothing and be always at work, or he may administer an empire and be at leisure. Let me suppose, then, that you have an hour a day and no more to expend upon literature.

There are two perfectly different ways of reading a book. It is curious that we often speak of reading as if it were always the same thing. But nobody, after consideration, will maintain that it is possible or necessary to read "The Proverbs of Solomon" and "King Solomon's Mines" in the same way. Bacon, in his "Essay upon Studies," puts the matter clearly: "Some books are to be tasted, others to be swallowed and some few to be chewed and digested; that is, some books are to be read only in parts, others to be read, but not curiously, and some few to be read wholly and with diligence and attention." It is fair to say that there will be a great saving of time if the number of books which require to be "chewed and digested" is made as small as possible.

I do not deny that the habit of concentrating the full power of the mind upon every chapter and page of a book is a discipline of very high value. The study of books written in a foreign language, whether ancient or modern, forms this habit and is principally valuable as forming it. In fact, it may be doubted if a person ever reads his own language in such a way as to appreciate its full meaning. But the great majority of books in a public library do not require and do not deserve to be so read. In looking at some statistics of the books taken out of one of the public libraries by the working classes, I notice that the class of books which is in most request is novels, and the class which is in least request is sermons. It is not for me, being a clergyman, to declare with what degree of attention sermons ought to be read. But I confidently say that nearly all novels admit of light and rapid reading. Where the point of a book lies in its narrative rather than in its style or substance, the process of "tearing out its heart," as it has been called, is the secret of alleviating labor. To some extent the same is true of history, and especially of that fascinating form of history, biography. You do not want to know or remember all the incidents; you want to grasp the general *contour* of the country (if I may use a geographical expression), not to be able to name every height and valley in it. Nor must it be forgotten that you have made an acquisition of knowledge which is well worth having, if your reading enables you, not indeed to produce your facts at an instant's call, but to discover where they are to be found and what they are, when leisure is given you. It appears to me, then, that one book in twenty should be read scrupulously; the rest may be read, so to say, *currente oculo*. But it is more important to read wisely than to read widely. Intellectual health, like physical, depends not upon the amount of food consumed, but upon the digestion.

And, if it be necessary to decide what books are they that should be read, not with the eye only, but with the soul, they will be such books as, in the German phrase, have been "epoch-making," and have exercised a lasting influence upon the current of human thought. They are not many; but in them is contained the essence of all literature. In religion, the Bible, and these two books which are most closely founded upon it, the "De Imitatione Christi" and "The Pilgrim's Progress;" in poetry, the writings, or some at least of the writings of the four great masters—Homer, Dante, Shakespeare, Goethe—who guard the portals of human sentiment for all time; in history, Thucydides and Gibbon as respectively illustrating the perfection of historical science in miniature and on a scale of majestic dignity; in philosophy, Plato's "Republic," which by the genius of the late master of Balliol has been made an English classic, and Pascal's "Pensées;" in political science, Aristotle's "Politics," Montesquieu's "L'Esprit des Lois," and Adam Smith's "Wealth of Nations;" in science, Bacon's "Novum Organum," Newton's "Principia" (if it be intelligible to you), and Darwin's "Origin of Species." These are all, or nearly all, the books that have been "epoch-making," and to read these will be to enter, however humbly, into the temple of knowledge and truth.

There is an exhilaration in the thorough study of noble literature. It gives tone and courage to the mind. The famous novelist George Eliot says it was her wont to seek inspiration for her writings by daily intercourse with the good and great writers of the past. May you learn the satisfaction of living, if but for an hour, each day in the company of the good and the great!

For the last word that I will say in the hope of enabling you to make the best use of the library which is now opened, is that you will do well if you read something that is worth reading every day of your lives. One hour a day amounts to many weeks in a lifetime; and it is not by doing great things now and then, but by doing something continually, that the best and most lasting results are attained. "The modern university," says Mr. Carlyle somewhere, "is a library." It is a university in which you all may graduate. It is a home which stands above the stress and pain of evil days. For literature, like virtue, is its own reward; and none but they to whom that reward has been given know or imagine how unspeakably great it is.—*National Review.*

CONSTANTINOPLE.

Of all the cities of Europe the New Rome of the Bosphorus, in its power over the imagination of men, can yield the first place to none save to its own mother, the Old Rome of the Tiber. And of all cities of the world she stands foremost in beauty of situation, in the marvel of her geographical position, as the eternal link between the East and the West. We may almost add that she is foremost in the vast continuity and gorgeous multiplicity of her historic interests. Those who approach Constantinople from Greece, as all men should, have sailed through that long panorama of island, mountain and headland which the Ægean Sea presents, past "Troy town" and the unknown home of its minstrel; and every rock recalls some tale or poem for the three thousand years since European thought and arts rose into being across those waters. The Hellespont has been passed with its legends and histories, and the Sea of Marmora with its islands of marble, its rich shores and distant ranges of mountain—and as the morning sun touches the crescents on her domes, the eternal city of New Rome bursts into view, looking on the east and the south across the blue waters of Propontis and Bosphorus, with her seven hills rising toward Europe one behind the other, each crowned with cupola and minaret, amid arcaded terraces, and groves of acacia, myrtle and cypress.

This glorious vision, if not the most beautiful, is the most varied and fascinating of its kind in Europe. Some prefer the Bay of Naples, or the Bay of Salamis, or of Genoa; but neither Naples, nor Athens, nor Rome, nor Genoa, nor Venice, have, as cities, anything of the extent, variety, and complexity of Constantinople, if we include its four or five suburbs, its magnificent sea landscape, its bays, islands, and mountains in the distance. For Constantinople does not stand upon an open sea like Naples or Genoa, but on a great marine lake with its shores, vine-clad hills, headlands and pearly mountain ranges in the far horizon. Like Athens or Venice, it has a seaport without an open sea outside. And as a city, it is vastly more grand and varied than Venice, Athens, Florence, or Edinburgh. Hence, Constantinople combines such sea views as we find round the western islands of Scotland or of Greece, with the summer sky and vegetation of Italy, and the mountain ranges which fill the horizon from the plains of Lombardy.

Was it more beautiful in the age of the empire than it is to-day? Perhaps from a distance, from the sea, the Stamboul of to-day is a far more striking sight than the Byzantium of the Cæsars. The minarets, an eastern and Moslem feature, are the distinctive mark of the modern city, and do much to break the monotony of the Byzantine cupolas. There are four or five mosques which repeat and rival the church of the Holy Wisdom, and some of them have nobler sites. Nor were the towers and battlements of ancient architecture to be compared in beauty and in scale with those of mediæval and Moslem builders. But the city, as seen within, in the Isaurian and Basilian dynasties, we may assume, in the five centuries which separate Justinian from the first crusade, must have greatly surpassed in noble art, if not in pictorial effect, the Ottoman city that we see. The enormous palace and hippodrome, the basilicas, churches, halls, and porticos with their profusion of marble, mosaic, bronzes and paintings, their colossal figures, obelisks and columns, the choicest relics of Greek sculpture, the memorial statues, baths, theaters and forums, must have far surpassed the decaying remnant of Stamboul which so often disenchants the traveler when he disembarks from the Golden Horn.—*Frederic Harrison, in the Fortnightly Review for April.*

WHAT I DON'T KNOW ABOUT ELECTRICITY.

By George Cutter.

I believe in electric lighting and cooking in isolated country homes by private plants and expect quite an increase in this line of work in this country in the near future. "I don't know" the best kind of a plant to recommend for this kind of work. So much has been done in this line in England that we could surely learn some good lessons by a careful study of domestic plants over there. I had the pleasure of assisting in the installation of one domestic plant in England, but it was not of a nature to afford much information for our work in this country. The plant cost $10,000 and was not planned for economy in working. A special house was built for the purpose and in this were installed steam boiler, engine, dynamo, storage batteries, and an array of testing instruments that would be frowned upon quite forcibly by an American electrician, as these private plants must be planned for practical work without expert attention and not as testing laboratories.

I have built a dynamo house by my suburban home and am puzzled what to install in it. When built it was my intention to install a boiler and engine well equipped with automatic stoker, regulators, etc., which would keep everything in proper working shape for runs of ten hours or even more. These automatic devices are all easily applied and would tend to develop domestic plants to such a degree of perfection as to lead to their adoption by many householders. I intend to pipe the steam to a system of indirect radiation for heating the house, and believe the cost of operating my plant, using exhaust steam for heating my house, would really be very little in excess of the cost of heating the house direct. Probably the best line of work for these domestic plants will be in this direction—studying simplicity and economy and making a special feature of automatically performing all the operations, so that a very little inspection and attention will be required. Of course the ideal plant involves the use of storage batteries, thus tending to make the first cost rather excessive. It is not absolutely necessary to use storage batteries, and I am not sure but the perfection of the automatic devices mentioned will render the expense of storage batteries very questionable, especially if cooking and other domestic work is done by electricity. The plant can then be operated all day and evening, the engine being merely placed in the path of the steam from the boiler to the heating system of the house.

Bearing in mind that this steam engine is almost a toy in such a case, two or three horse power generally being sufficient and ten horse power very large, such plants should be developed complete by the parties who intend to push their sale, and furnished like complete bell outfits "ready to put up." The buyer cannot buy dynamo in one place and engine in another, etc. Imagine the perplexities of a man who makes it known that he intends to install a lighting plant in his house. The number of "best" and "only correct" devices for each separate part of the plant that would be presented would overwhelm a giant intellect and probably cause the party to feel he had found a great den of thieves from none of whom he could learn the truth.

A gas engine is also a fine method of operating private plants for those residences that have gas in them. Even those that have private gas plants can send the gas through a gas engine to make electric lights and get a certain amount of light for less expense in coal than by burning the gas direct for light. Gasoline and kerosene engines are probably the cheapest of all for small powers and are easily installed and operated. My reason for hesitating about installing the steam engine outfit in my house is not because of a doubt of its being the best, but because of a little sentiment, viz., a desire to play with the problem on lines that might develop more practical and simple means of domestic lighting and cooking. Some fine day in the near future we are going to learn how to produce electricity direct from crude materials at much better efficiency than through the boiler and engine. Possibly a primary battery that will yield valuable by-products may come before the cheap electric generator above hinted upon, but these batteries are not likely to help much in isolated residence lighting, as the owners will not care to become by-product dealers. The makers of such batteries could of course buy all the valuable by-product. Primary batteries without valuable by-products can be made so as to be useful for residence lighting and at a cost that will not be prohibitive. And my present hobby lies in this direction. It is a promising field to work in.

Large thermopiles (furnace generators of electricity)

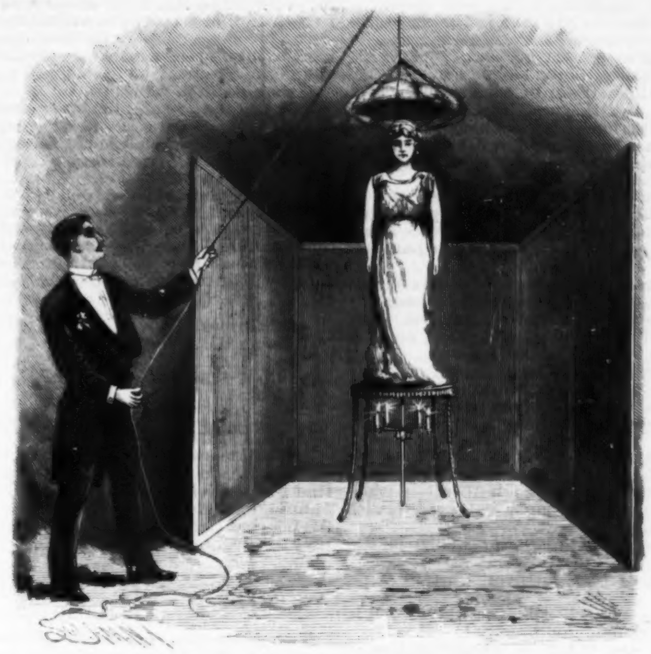
afford an equally interesting field of work, but probably less promising than primary batteries. Available water power is not open to discussion, as the lucky owner of a water power large enough to do his lighting and cooking by electricity is unquestionably in possession of the means of procuring the greatest of house comforts, natural gas not excepted. A great field for this work is open to the enterprising engineers in the irrigation regions of the West. Windmills come in for the last method to be suggested in this paper, and to be passed over lightly, as they are simply not in the race at all. If a moderate breeze would develop enough power without a giant windmill, or if strong breezes would blow with such regularity as to afford a fair daily average, this method would be the prize winner. But as a gentle breeze does require an enormous wheel for the power, and as stiff breezes are very irregular and often much too strong, thus using up the total mileage per month in a few storms, the windmill is simply not in the race.—*Electrical Industries.*

A CREMATION SCENE.

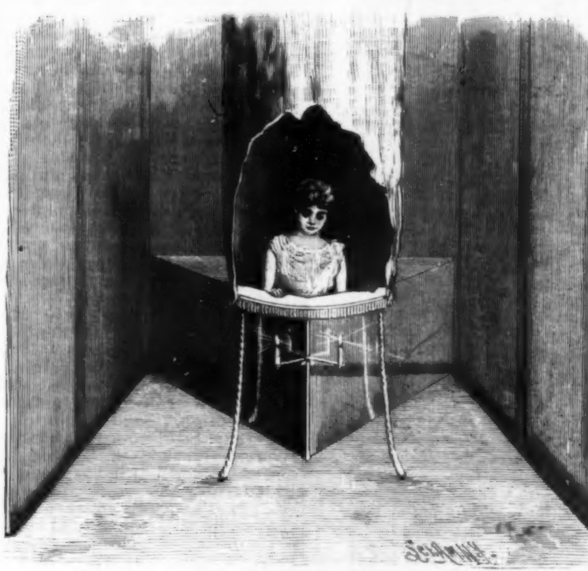
AMONG interesting things to be seen at the Eden Musee, in this city, perhaps one of the most curious and at the same time scientific is the weird spectacle entitled "She," exhibited by Powell, the well known illusionist, and suggested by the Cave scene in Rider Haggard's celebrated novel "She."

In this scene a beautiful young lady mounts a table arranged in an alcove formed of a folding screen. Above the victim is suspended a cylindrical cloth screen. The screen is lowered to the level of the table, completely inclosing the subject. The table apparently has four legs, and four candles shown beneath it indicate that the space underneath the table is open and clear. The cylindrical screen is shown to be entire, with openings only at the upper and lower ends, and no openings are seen in the folding screen which partly surrounds the table. Upon the firing of a pistol the occupant of the table is ignited, and smoke and flame bursting from the screen indicate that the work of destruction is going on within. When the fire is burned out the screen is lifted, and nothing remains upon the table but a few smouldering embers and a pile of bones surmounted by a skull. Close observation does not reveal any way of escape for the young woman. It is, however, obvious that the magician cannot afford to sacrifice such a subject every evening, and the spectators are forced to conclude that the whole affair is a very clever trick. In fact, it is simply a modification of the beheaded lady and numerous other tricks based upon the use of plane mirrors. The table has but two legs, the other two which appear being simply reflections. The central standard supports but two candles, the other two being reflections. Underneath the table, and converging at the central standard, are arranged two plane mirrors at an angle of 90° with each other and 45° with the side panels of the screen. By means of this arrangement the side panels, which are of the same color as the central or back panel, are reflected in the mirror and appear as a continuation of the back panel. The triangular box, of which the mirrors form two sides, has a top composed in part of the table top and in part of mirror sections for reflecting the back panel, or with a covering of the same color as the back panel.

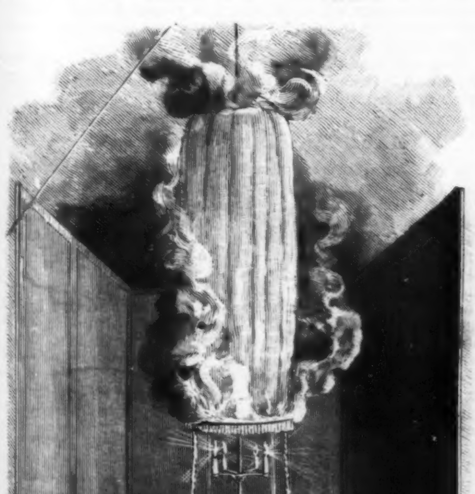
The operation of the apparatus is now obvious. When the victim is inclosed by the cylindrical screen, she immediately escapes through a trap door in the table top, places the bones and the fireworks upon the table, and at the firing of the pistol ignites the latter and retires, closing the trap door after her.



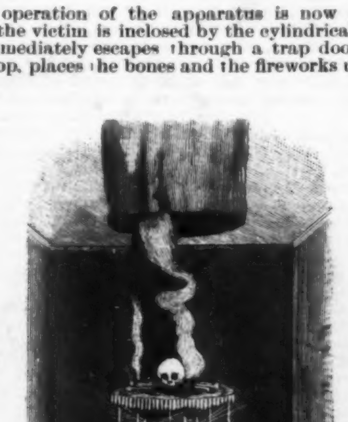
PREPARED FOR CREMATION.



THE ESCAPE.



THE BURNING.



THE FINISH.

THE USES OF BORAX.

By E. L. FLEMING.

BORAX is a white, crystalline substance, peculiar to the mineral kingdom; it is a very mild alkali, of a pleasant, sweetish taste, and is not injurious to the human system; it is freely soluble in water; its solution acts as a solvent for resins, albumens, fatty acids and certain organic bodies that are not soluble in water alone; but it does not appear to attack fibers, membranes, tissue, or skin. In the crystalline state or in solution, it is very easily decomposed by such acids as tartaric acid or acetic acid; but in its calcined or anhydrous state, when fused, the boracic acid it contains acts as a more powerful acid than even sulphuric acid.

Borax, in the crystalline state, contains 47½ per cent. of its weight of water, to which it tenaciously adheres at the ordinary temperature of the atmosphere, time seeming to have very little effect upon its character. At the boiling point of water it slowly parts with nearly the whole of this water, and if the process be conducted quickly, at a still higher temperature, the borax swells to several times its size, becoming a body of a light and porous nature, which may be crushed to a compact powder.

At a higher temperature than 450° Fah., it melts to a clear glass, which remains transparent on cooling. Though the applications of borax are not generally known, as a fact this interesting and valuable salt will be seen to be utilized in different ways by several industries.

For goldsmiths a special grade of borax is prepared, called jeweler's borax, in pieces as solid and free from cracks as possible, so that when rubbed on a slate with water it is not liable to fall to pieces, but will gradually wear away until too small to handle conveniently, when the small pieces are put on one side, to be used as a flux in melting or collecting.

An enameled coating for cast iron and steel as well as copper is made by fusing on the metal a mixture of quartz, feldspar, clay and borax, and then covering it with a glaze containing borax. It is thus extensively used in the manufacture of enameled iron mantel pieces, made to represent the rarest marbles, and in the great variety of enameled signs and hollow ware. Borax is also used in conjunction with infusorial earth for lining fireproof safes, for being a salt that contains nearly 50 per cent. of its weight of water of crystallization, with which it parts at a high temperature in the event of fire, the steam arising from the heated borax permeates the books and papers in the safe, and prevents their being burned.

For this purpose it is superior to alum, which is an acid salt, and has a tendency to corrode the iron. At a red heat the boracic acid in borax readily dissolves and unites with metallic oxides, forming a fusible glass, which property renders borax of great use in conjunction with other fluxes, for certain mineral and metallurgical processes.

In brazing copper it is used for cleansing the parts to be joined, on account of the property it possesses of dissolving the oxides that form a film upon the metal. It is very extensively used in the manufacture of copper pipes and for other purposes.

In welding iron and steel together it answers the same purpose. Machinists and others use the crystal for chilling the iron to the right temperature, for the purpose of casehardening or tempering different portions of machinery or implements to the desired degree.

Borax has recently been applied with considerable success to the manufacture of optical glass at Jena. This glass has very high refractive properties, and has been very successfully applied to the manufacture of lenses for microscopes and for photography.

Borax is now used in glazing china and earthenware so extensively all over the world that the consumption in these industries, at the present time, exceeds any of the others. The principle adopted is to form a fusible glass of borax and other materials, and fuse it on to the baked earthenware. Many formulæ have been published of the composition of this frit, but almost every large firm have their own formula.

In the manufacture of Parisian cement the borax is

added for the purpose of enabling cement, when set and moulded, to take a polish.

In the chemical industries it is used in the manufacture of soap, colors, drysaltery, and cosmetics; also in photography and timber preserving.

There are many kinds of borax soap. From all accounts its use in this industry arose from the fact that the linen of Holland and Belgium became celebrated on account of its superior whiteness, in the cleansing of which borax was used as a soap powder; and hence we find that dry soap, soft soap, and toilet soaps are now made with it.

In the manufacture of colors borax is used, and in the preparation of borate of chromium, a pale green powder, and borate of copper, a darker green. These are used as substitutes for arsenical green in painting and dyeing.

In drysaltery it is used in the shape of borate of lead and borate of manganese. Both these products are used in the manufacture of varnish (as driers). The borate of lead is used for the palest varnishes, and the borate of manganese in other varnishes.

As a cosmetic it enters in the composition of many preparations for the hair, the face, and the hands.

Photographers use it in the toning bath to govern the action of chloride of gold, which is dissolved in conjunction with it.

In the preservation of timber it is used for dissolving the albuminous resinous matter, or the sap, which readily decays, leaving only the tough fiber.

Borax dissolves caseine, forming a substance which can be used as mucilage.

In silk it serves for dissolving the glutinous matter adhering to raw silk.

In calico printing it is used for fixing certain colors as a mordant.

Laces, muslin, tulle, and other light fabric steeped in a solution of borax are rendered fireproof.

Hat manufacturers use borax for dissolving shellac to form a stiffening for felt hats made of wool. A weak solution of borax is used after the felt body is proofed, to wash from the surface any excess of stiffening not required upon the face of the felt.

Candle wicks are prepared with a solution of borax. Its use is to cause the wick to curve in burning, and at the same time to vitrify the ash. It also prevents the wicks from burning too rapidly, and obviates the necessity for snuffers.

In the leather industries it is used in curing and preparing skins by leather dressers and leather dyers.

It is used as a mordant in dyeing leather with aniline colors. And also in polishing, a little borax in the blacking or coloring is added to enable the iron used in polishing to pass freely over the leather. It prevents the iron sticking and increases the glaze.

Pork packers use powdered borax for sprinkling over hams and bacon. Thousands of tons of meat are thus annually preserved in America.

Fish curers use a mixture of boracic acid, alum, and salt for keeping herrings fresh. The principal seat of this industry, so far, has been at Hangoesund, near Stavenger, in Norway.

Having thus practically demonstrated its usefulness, let us turn our attention to the sources from whence it comes. England has no borax fields or mines, and at present the material, either in the manufactured state or that from which it can be manufactured, comes from Thibet, Italy, Chile, California, and Asia Minor. Thibet is the most ancient source, and, under the name of "tincal," borax is brought from the neighborhood of Yam-dokcho to Calcutta, from which port the source of origin is distant between four hundred and five hundred miles almost direct north. At the present time there is railroad communication as far as Darjeeling, or a distance of three hundred miles.

There is also a borax refinery at Jagadhri, thirty-seven miles southeast of Umballa, in northern India—all the borax which is exported from India being brought from the trans-Himalayan region.

The manufacture of borax, as far as England is concerned, divides itself into two classes—the manufacture of borax from boracic acid and that from sesquiborate of lime and double borate of lime and soda.

The mere refining or recrystallizing of crude borax requires no skill at all. The manufacture of borax from boracic acid imported from Italy involves several processes. The sulphates of ammonia and magnesia have first to be washed out of the crystallized acid, and this is effected by reason of their superior solubility. The boracic acid is then boiled in large iron pans, with the requisite amount of carbonate of soda, the impurities allowed to subside, and the clear liquor run to large iron vats to crystallize. This first borax is not pure enough for commerce, and requires a second crystallization.

The impure borax liquors are boiled down, and, upon reaching a strength of 60° Twad., or 1·300 specific gravity, are allowed to recrystallize and throw down a further crop of borax. Before the mixture reaches a temperature of 80° Fah. it is drawn off into other vats to allow the sulphate of soda to crystallize out, and, finally, the liquor is raised to the boiling point, and concentrated, in order to get rid of the common salt.

Borax manufactured from boracic acid is liable to be tinged with various colors, such as black, green, or yellow, on account of impurities contained in the acid or the soda ash, and are due to the presence of sulphides or oxides of iron. In order to overcome this difficulty the borax is bleached when in a state of solution.

The manufacture of borax from boracite, colmanite, or ulexite presents a new feature that does not appear in the manufacture from boracic acid, and that is, that when any of these minerals are reduced to a state of the finest powder, and boiled with carbonate of soda, what is known as borate of soda, as well as biborate of soda, is formed.

The biborate of soda or borax crystallizes out in the ordinary way, but the borate of soda remains as a thick sirupy liquor, which has to be decomposed either with carbonic acid, boracic acid, or bicarbonate of soda. If this is not done, loss is apt to occur, and the full strength of the mineral is not obtained.

With such abundant supplies of borate of lime throughout the world, it becomes a question of transporting the boracic acid it contains in as concentrated a form as possible, especially in those regions where the quality is but poor, and, therefore, many plans have been devised. One of the simplest is what is known as the sulphurous acid process, and this is to be preferred to others on account of the small quantity of sulphur required to extract the boracic acid.

The process consists in burning sulphur, and injecting the sulphurous vapors into the decomposing vessel, where the borate of lime is kept in a state of agitation and suspension in water.

Only one ton of sulphur is required to produce five tons of acid, and the saving effected in cost of transportation, where it takes two or even three tons of borate of lime to produce a ton of boracic acid, requires no recommendation.

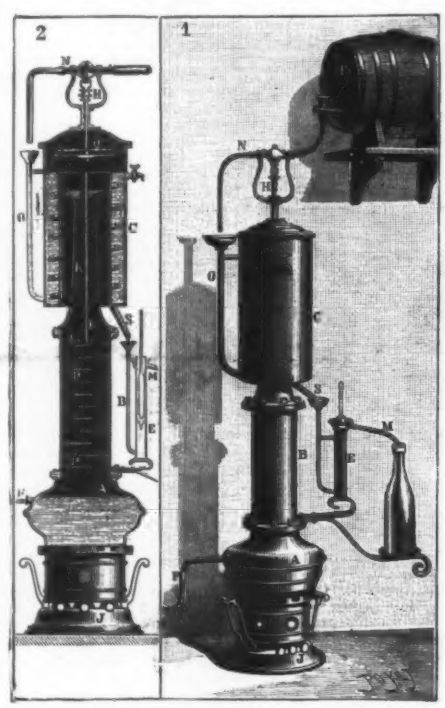
Various estimates have been made of the consumption of borax throughout the world, and one of the methods of ascertaining this is by referring to the productions of different countries and converting the different materials in their equivalent of borax. We thus find the production to be as follows:

	Tons.
Asia Minor	8,000
Thibet	2,000
Italy	3 000
United States	6,000
Chile and Bolivia	3,000
Total	22,000

As the American and Asia Minor supply has been developed within the last twenty years, it will be seen that the uses of borax, to the extent of 14,000 tons per annum, have increased during that period, or nearly 300 per cent., and it may be taken for certain that its uses will still further extend.—*Chem. Trade Jour.*

FAMILY STILL FOR CONTINUOUS DISTILLATION.

THE production of alcohol in France is submitted to very severe fiscal laws, enacted for the twofold purpose of arresting the progress of alcoholism and furnishing the treasury with a portion of its revenue. It has been necessary, however, in the presence of certain considerations of various kinds, to make an exception in favor of owners of cultivated land who desire themselves to convert their crops into alcohol, and who are designated as *bouilleurs de cru* (distillers of wines and fruits). Occasion has been had several times to discuss the complete or restricted exceptions that they should have the benefit of, and the question, which is very complex, has not as yet been very completely elucidated. It will doubtless often return to the front. Some, who are partisans of the total exemption from tax, take as their basis the right of which a landowner cannot be deprived of transforming the products of his harvest himself as he prefers to. Others, who are enemies to the privileges granted to these distillers of wine and fruits, assert that it is to open a door too widely to fraud, and they are perhaps not wrong, since alcohol is exempt only so long as it is not delivered to commerce. If the manufacture is no longer controlled, the sale becomes difficult of surveillance. However this may be, exemption has almost always prevailed up to the present, and, although twice (in 1804 and 1873) restrictive laws have been enacted, their application has lasted but a very short time.



NEW CONTINUOUS STILL.

We make no pretension to decide, nor even to discuss the question, but shall confine ourselves to an examination of what the means are that are ordinarily employed by the small landowner who manufactures his own cognac, kirsch and fruit brandies, and to making known a new apparatus that we saw at the last agricultural exposition, and that appeared to us very practical.

In most cases, the farmer employs but slightly improved apparatus, either because they belong to him or because he has made application to itinerant distillers who make a business of repairing to the husbandman's place during the winter.

The apparatus consists, as a general thing, of an ordinary still, that permits of distilling upon a water bath in order to prevent an overheating, which would give faints; but the latter may proceed likewise from alcohols of the first and last run, which become mixed, besides, if the operation is not well conducted. So distillation with such apparatus is quite a delicate matter and requires a continual surveillance in order to give good results.

In the large industrial continuous distillation stills special measures have been taken, the principal one of which consists in the use of the arrangement known in laboratories as Wolf's vessels, and that permit of utilizing the phenomenon of the successive ebullition of alcoholic liquids, whose point of vaporization is, as we know, so much the less elevated in proportion as they are richer in alcohol. Greatly improved portable apparatus based upon this same principle have been made for some time past. Mounted upon wheels, they can be easily transported, but they are quite high-priced and are applicable rather to the purposes of those who have a large harvest. For the small farmer, who has but little to distill and does not wish to apply to the industry, Mr. Esteve has endeavored to realize on a small scale the same advantageous arrangements that are found in the industrial apparatus, and has had Mr. Bernard construct a cheap apparatus that permits, despite its small bulk, of distilling a relatively large quantity of liquid, because the operation is continuous.

The regularity of the heating, which is an essential condition for a good distillation, is obtained through a petroleum furnace with multiple wicks, that permit of regulating the flame in a precise manner. Upon this furnace, J (see figure), is placed the apparatus, which consists of a copper, A, surmounted by a column, B, and a worm, C. This latter is not surrounded with water for cooling it; it is the liquid itself that is to be distilled that fulfills this office and that begins from this moment to become heated. This of itself effects a considerable saving in fuel. The liquid may be contained in any sort of reservoir, such as a small cask, T, placed above the apparatus. It falls into a funnel, O, fills in the cylinder, C, the space comprised between the spirals of the worm and then overflows through the tube, G, which debouches in a small cup, L, forming a hermetical joint for the air and vapors, but allowing the liquid to flow continuously over plates, P, arranged in the column, B (Fig. 2). All these plates are flat, without flanges, and contain an aperture. They do not retain the liquid, but serve to divide it before it enters the copper, A. It thus presents a wide surface of evaporation which facilitates the disengagement of the vapors of alcohol, and when it enters the copper it contains scarcely anything but water and last run faints, but whose point of evaporation is more than 100°. They are, therefore, not collected, but make their exit through the waste pipe, F, which keeps the level constant in the copper. The vapors disengaged meet with the plates in ascending and make their way in a direction contrary to that of the liquid, so that the latter condenses the vapors the least charged with alcohol until allowing of the passage only of the richest, which unite with each other in the cone, R, at whose upper part the worm debouches. They entirely condense in the latter and flow in the form of alcohol through the extremity, S, of the worm into a test glass, E, into which dips an alcoholmeter that permits of showing at every instant whether the desired degree is obtained. The test glass is provided with a waste pipe, M, that debouches in the final receptacle.

It will be understood from what precedes that the flow of the liquid into the funnel, O, should be so regulated that it shall circulate slowly enough in the apparatus to permit of the complete exhaustion of the alcoholic vapors, while at the same time keeping the worm at a temperature sufficiently low to obtain a condensation. Such regulating may, through feeling one's way, be obtained by hand in turning the cock of the reservoir more or less, but that would necessitate a surveillance that it has been desired to avoid. So the inventor has arranged an automatic regulator that consists (Fig. 2) of a small receptacle, Q, of thin metal, containing a volatile liquid. This is fixed beneath the cover of the refrigeratory, which supports likewise the valve cock, N, that controls the entrance of the liquid. A rod carrying a nut, H, moves freely between this valve and the receptacle, Q. When the latter expands, in consequence of the elevation of temperature, it thrusts the rod, which opens the valve and allows more of the liquid to flow. A contrary operation takes place if the temperature falls. On regulating the length of the rod by means of the nut, H, in a preliminary experiment, according to the degree that it is desired to obtain, an equilibrium is reached that is preserved during the entire course of the operation and surveillance becomes unnecessary.

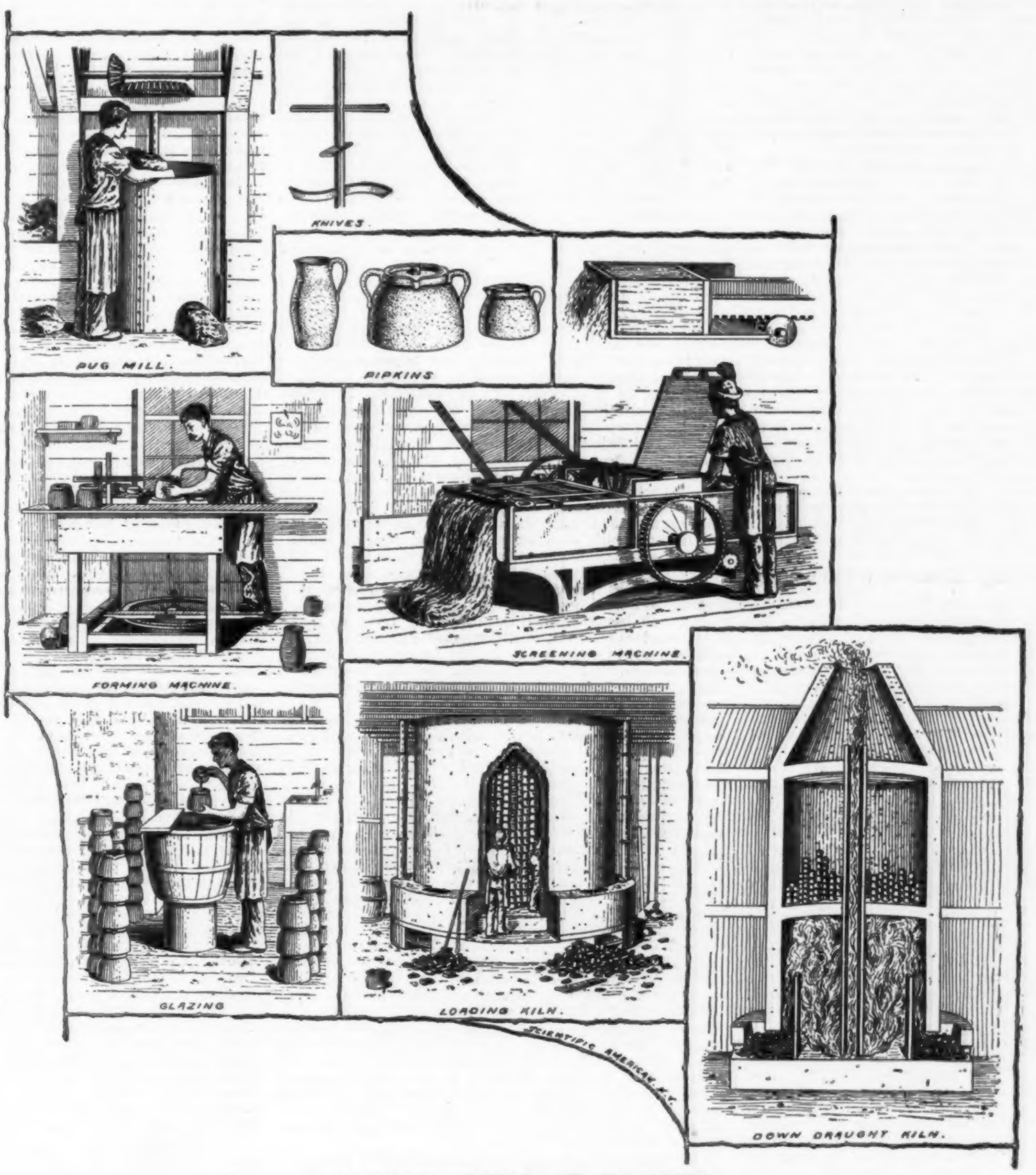
This still has appeared to us a very practical one for the small farmer. It is made in different sizes and the price of it is moderate.—*La Nature.*

MANUFACTURE OF PIPKINS.

A GREAT quantity of the clay used in the manufacture of pottery and bricks comes from the State of New Jersey. There are large tracts of the material on each side of the Raritan River, between South Amboy and the city of New Brunswick. The clay is slate colored and of different qualities. The beds or pits in some places are 50 ft. or more in depth, and run from one-half to one mile in width and length. Large plants engaged in the manufacture of pottery and brick line the river on each bank. The clay is shipped to the potter in a hard, chunky state, being first moistened with water, and then run through a pug mill and screener before it becomes of the right texture to be worked into pottery. The first operation in the manufacture of pipkins after the moistening the clay is the tempering of the material in the pug mill. This mill is circular in shape and made of wrought iron, about 4½ ft. in height, about 3½ ft. in diameter, and about ½ in. in thickness. An upright shaft with a number of knives attached revolves around in the center of the apparatus at the rate of 75 to 100 revolutions per minute, causing the clay to be worked up in a soft dough. About 600 lb. of the material is placed in the mill at a time, and after being worked up by the knives for about fifteen minutes, it is forced out through an opening at the bottom by the two lower knives, which are shaped so that in making their revolutions they both pass through and force out the material through the opening below. The tempered clay is then taken up and put into the screening machine. About 200 lb.

of clay is put into an iron box at the end of apparatus which is about 3 ft. in length, 2 ft. in width and about 18 in. in height. Across the front end of box is a piece of wire netting, 24 meshes to the inch, through which the material is forced. The clay is pressed through the meshes by means of a movable plate or ram. Connected to the back of the plate are two square iron bars, the under sides of which are slotted. These bars pass over two gearing wheels underneath, which when the machine is in motion forces the ram ahead, which in turn presses the clay through the meshes of the netting. The box or machine empties itself in about two minutes. The material is then taken up and weighed out into 2 and 7 lb. pieces to be formed into pipkins. The next operation is forming. A piece of clay is placed on a circular wooden block about 14 in. in diameter, attached to the under side of which is an upright shaft. This shaft connects itself below to a 3 ft. drive wheel with a treadle attachment. The operator, to make the circular block with the ball of clay revolve, forces the treadle back and forth with one of his feet, causing the block to revolve at any rate of speed. The pipkin is formed entirely by the hands, the attendant pressing into the center of the ball of clay, which by holding the hand in a certain position causes it to grow in height, thickness and in a circular shape, the point of the gauge showing the attendant when the required size is reached. A good operator can form from 18 to 50 pipkins per day, according to size, which run from ⅛ pint to 1 gallon. After forming they are put into the upper part of a kiln to dry. As soon as they can be handled they are glazed. This requires three operations, the first two being on the inside and the other on the outside. The first process is a white body mixture, consisting of a solution of feldspar, flint, china clay and ball clay. The second process consists of the same ingredients, with the exception of ball clay, with addition of zinc, Paris white, and dry white lead, the materials being mixed up with water and run through a 120 mesh sieve. The pipkin is held in one hand and the solution poured into it with the other. After the inside is thoroughly saturated the solution is poured out and the pipkin put one side to dry, which takes about 4 or 5 hours, the coating drying white. They then pass through the next operation on the outside, which is done by dipping, the attendant spreading his hand out on the inside of the pipkin and pressing it down into a mixture called black lining or Albany slip. An operator can glaze from 1,200 to 1,500 per day. After they can be handled they are placed in the lower part of kiln to burn. The kiln is about 30 ft. in height, 12 ft. in diameter, 2 ft. in thickness at the bottom and made of brick. It is divided into two compartments, the upper one for drying purposes and the lower one for burning. It is called a down draught kiln, having an 18 in. square chimney running up through the center. Each compartment has a convex crown 9 in. in thickness. The lower kiln is about 10 ft. in height and the upper about 8 ft. The lower kiln is fitted up with seven 6 × 18 in. fire bags. After the lower kiln is loaded up with about 1,800 pipkins, the doorway is plastered up and the fires started. The flames from the fire pits rise up through the bags on the inside to the crown above and down to the bottom of the kiln, where they pass through eight holes in the bottom corners of the chimney, passing out at the upper end. After burning for about twenty-four hours at a white heat, the fires are then put out and the kiln allowed to cool. After cooling, the pipkins are taken out and packed for market. The clay is bought by the ton, the price varying from $1.50 to $5 per ton, according to the grade.

Our sketches were made in the establishment of John J. Leonard, West Bergen, N. J.



MANUFACTURE OF PIPKINS.

SOME RECENT ADVANCES IN PHOTOGRAPHIC CHEMISTRY.*

By CHAPMAN JONES.

PHOTOGRAPHY, as ordinarily practiced, is an empirical art. Although it is founded upon, and intimately connected with, certain branches of chemistry and optics, very few photographers know anything of these sciences. The ordinary practitioner, whether amateur or professional, works entirely by rule of thumb, and is guided by tradition rather than by reason. It is natural, and perhaps necessary, that this should have been so at first, but it must be allowed that the sooner the art is put upon a sure foundation the better, though doubtless there will always remain some who will prefer the old ways.

There is now a larger amount of scientific work being done in connection with photography than heretofore, and I would suggest that the time has come when we should make a determined effort to get rid of uncertain and obscure processes in serious work. When one's only aim is amusement, then, of course, there must remain free liberty to follow any fancy, but for the production of valuable records of any sort, whether pictorial or otherwise, I think the time has come when photographers ought to avail themselves to the fullest extent of all the scientific knowledge at their disposal. Any who are unable to guide themselves should, as is usual in other industries, seek the advice of those who are able to give them assistance.

As an example of the disastrous effects of working in the dark, I may say that I have heard of photographers, both amateur and professional, who have many large and valuable negatives intensified by the mercury and silver cyanide process that have so much changed from their original condition as to cause grave anxiety. It would have been wise, though perhaps hardly possible, if photographers had declined to use this process until it had been properly investigated by a chemist. Then no trouble would have ensued.

We may for convenience sake, with reference to the majority of photographic operations, divide the photographer's work into two parts, namely, the making of the negative and the making of the print. If we accept those cases in which, for scientific purposes, the negative itself is preserved as the record, as, for example, in spectrum work, then the end and aim of the photographer is the preparation of the print, and the negative is nothing more than the tool used in its production. In this sense, therefore, the print is of much more importance than the negative. It should be of a permanent character, while the tool used in the making of it may perfectly serve its purpose, though it were so shortlived as to fade away immediately after it had yielded the print. But it is convenient, and often of great importance from an industrial point of view, that the negative shall be stable. And if the negative is not right, the print must be wrong, and if the negative is produced by uncertain processes, we never can tell what the print will be. The science of negative making becomes therefore, I think, of as much importance as the science of printing processes. As the chemistry of these latter has received enough attention to enable any one to make prints that are perfect from a chemical point of view, while the chemistry of negative making has been very largely neglected, I have spent a good deal of time during the last few years in examining some of the operations in common use, and propose this evening to look at one or two matters in connection with the chemistry of negative making on gelatine plates.

The silver bromide particles held in the gelatine film are so changed by suitable exposure to light that the developer is able to take away the bromine from them. In a chemically perfect negative, after fixing and washing, the image will consist of pure metallic silver, and it does not matter at all where the bromine has gone or what changes it has produced in the developer, so long as no trace of it, or what it leads to, remains behind. But when bromine is added to an alkaline solution of pyrogallic acid, it produces a brown color, and as there

* A recent lecture before the Society of Arts, London. From the Journal of the Society.

is most bromine removed where there is most silver deposited, the brown coloring matter will be, roughly speaking, proportional in quantity to the density of the negative, unless some of it is removed. There is, perhaps, no *prima facie* reason why an image of this composite character should be objected to. Indeed, the presence of this brown stuff may improve the negative if the film has too little silver in it to give proper density alone, or if the exposure has been too short to change a sufficient amount of the silver bromide into the developable condition, or if the development has been unduly curtailed. It is easy to see, therefore, that a cheap manufacturer and an incompetent, rule-of-thumb photographer may have definite reason for advocating the use of the stain-producing developers. But to rely upon staining matter in the making of negatives is to lean upon a broken reed. The residues obtained by the partial destruction of some complex organic substances are almost pitchy in character, and seem to be very unalterable by ordinary atmospheric influences. But the staining matter produced by the oxidation of developers, so far as I have yet discovered, is never of this kind. Pyrogallic acid generally yields brown products, inclining sometimes to red and sometimes to yellow; but twice I have obtained solutions of so fine a deep blue color that it might have been mistaken for Prussian blue. These blue colors, on standing for a few hours, faded to a yellowish brown. The deep reddish brown color obtained by simple aerial oxidation of a solution of pyrogallic acid and sodium carbonate becomes perceptibly lighter in a day or two when bottled up, and in a week or so may have lost perhaps half the depth of its color. I think one is quite justified in saying that neither the quantity nor the quality of these staining matters can be controlled, that they are in every way uncertain, and that, therefore, they ought to be rigorously excluded, or perfectly removed, from every negative of value.

And these are far from being all the reasons why the presence of staining matter in negatives should be avoided. A silver image is reliable, and can be chemically worked upon with perfect certainty as may be desired. But staining matter cannot form a foundation for after work, and it will suffer change with almost every operation upon the negative. Its color will change and rechange, and by washing it will, under some circumstances, be partly removed. We know very well that when a part of the image is removed by applications to the surface of the film, the shadows lose a greater proportion of density than the lights, because the dark detail is in the upper or outer surface of the film only, and so is more easily attacked. Therefore, granting for the moment that a negative with an image that consists partly of staining matter has correct gradation, if a part of the staining matter is removed the gradation will be falsified, and this alone would be sufficient reason for condemning the use of staining matter in negative making.

There is another source of staining matter, namely, the oxidation of the developer by its exposure to the air during development. The coloring matters so produced may or may not be the same as those resulting from the action of bromine, but, so far as my experiments go, they behave in a similar manner with reference to those changes that are of practical interest to photographers. The darkened solution will soak into the gelatine and color it more or less uniformly, and it appears that it may perhaps also intensify the image by deposition upon it, if we take into account recently published experiments. Mr. A. W. Dolland* has shown how by the use of glycerine gold may be deposited upon the metal in a platinum print, the platinum apparently remaining quite unaffected, and merely determining by "contact action" the precipitation of the gold from a solution that is ready to deposit it upon the least disturbance. Mr. E. J. Wall† has confirmed the results of earlier workers, who found that silver might be similarly deposited. And coming still more closely to the point under discussion, Dr. R. E. Liesegang‡ has recently observed that substances of the nature of pigments may be deposited upon a metallic basis in an analogous manner. He found that the staining matter produced by the aerial oxidation of pyrogallic acid, hydroquinone, and similar substances in alkaline solution would deposit upon and intensify the image of a silver print. A solution of amidol with carbonate of soda he found would deposit colored oxidation products upon the image of a platinum print. It is, therefore, but natural to suppose that probably sometimes the staining matters produced by aerial oxidation in developers will deposit upon the image in negatives, and add to the oxidation products that are already there, produced by the action of the bromine, as before described. I have made one experiment in this direction, by soaking part of a negative in an alkaline solution of pyrogallic acid, allowing it to remain until the solution and the negative were both well colored, and then washing for a short time. The color, of course, retarded printing, but I could not discover any intensification effect. It is possible that the staining matter produced by aerial oxidation may attach itself more readily to the image when the image is freshly formed, or it may be that it does not attach itself to the image at all under the conditions which hold during development.

Every photographer knows how to set to work to avoid the production of staining matter, but I think that very few know how to get rid of it when it is in a negative. The usual method is to apply an acid solution—a so-called "clearing solution." The stain may disappear, and then the photographer imagines that it has gone. The error of this empirical and rule-of-thumb method can be easily demonstrated. If hydrochloric acid, sulphuric acid, sulphurous acid, or alum, is added to an oxidized alkaline solution of pyrogallic acid, the brown color is changed to a lighter brown, and immediately a yellowish insoluble matter begins to fall out of solution, and continues to increase in quantity for some considerable time. In a negative where there is not much stain this change of color may cause it to disappear, and the superficial observer would then think that he had got rid of it, while really he had made it, or a large part of it, more permanent than before by rendering it insoluble. It is easily shown that this precipitated matter generally constitutes a very important part of the staining material, by dissolving it in carbonate of soda and comparing the color so obtained with that of the original or of the part not precipitated. Citric acid differs from the acids mentioned above, in that it gives no precipitate, but citric acid and alum together give a copious precipitate, even when the quantity added is many times more than sufficient to render the solution strongly acid.

It appears, however, to be possible in aggravated cases to get a small residuum of stain from the use of pyrogallic acid, and rather more from the use of hydroquinone, which it is very difficult indeed, if not impossible, to remove. This residual stain I find to be quite unaffected in appearance by any of the usual clearing solutions, unless they contain iron, and then the color is somewhat changed in tint, and if anything a little darkened. It may be remarked, also, that staining matters vary somewhat, and that exceptions may be found to the results that I have described, but I believe that such exceptions, if any exist, will be found so rarely that it will be practically impossible to take cognizance of them in framing rules for general work. Ferrous oxalate has often been recommended as the most perfect developer when stainless negatives are desired, but although ferrous oxalate is a very useful reagent, I cannot confirm the superiority that is claimed for it. Every developer in use will give clean, grayish black negatives, if properly employed, but by making a careful comparison of ferrous oxalate with eikonogen on a plain gelatine film, I find the iron developer to leave a slight color, which is very difficult, if at all possible, to remove, while the eikonogen leaves none. I have no doubt whatever that metal, amidol and rodinal would all show a like, if not a more marked, superiority. It may be observed that in making such comparisons it is necessary to use a simple gelatine film, because the stain left by ferrous oxalate, when it is applied in the same manner as is usual in development, is easily masked; and it should be understood, too, that the difference is slight. Still what difference there is, is in favor of the alkaline developer.

The rules for practical work that I have deduced from my experiments I have followed for some years with uniform success, nor have I ever heard of dissatisfaction from those who have accepted my suggestions in this matter. I believe that the greatest freedom from stains due to the developer is secured by the use of an alkaline developer with sufficient sulphite, and fixing in a solution of hyposulphite to which sodium sulphite and sodum carbonate have been added. A very few minutes washing between development and fixing is sufficient, but the fixing solution should not be used after it gets dirty or discolored. After thorough fixing should follow a thorough washing, and with a well coated plate this will be a matter of two or three hours or more. By this method any staining matter is kept in its most conspicuous form, and in its soluble, and therefore most readily removable, condition; and it must surely be allowed that this is the right principle to work upon. Alum should never be used until the washing is finished, because it retards the washing; so-called "clearing solutions" should not be used, both because they tend to make the stain less obvious, and they make its removal impossible; acid fixing baths should be avoided for the same reasons, and if they harden the film, their use is still more detrimental, because in doing so they render the washing more tedious or less perfect.

Having obtained a pure silver image, it may be found that its density is not suitable. It is well that the density should never be too great, because there is no practically useful method of reducing it that does not alter the gradation. On the other hand, intensification is certain and easy, and does not falsify the gradation, when done in a suitable manner. In papers read before the Photographic Society and the Society of Chemical Industry, I have detailed the chemistry of mercurial intensification, and shown that ferrous oxalate is the only reagent that can be relied upon to follow mercuric chloride. Potassium silver cyanide is not suitable, because the image it gives is not of constant composition, and is not permanent; ammonia is unreliable, because it gives images of complex and varying composition, which cannot reasonably be expected to be permanent; all simple alkalies are out of the question; sodium sulphite gives a pure metallic image, but in smaller quantity than the original image, and often, therefore, gives no intensification effect; sodium hyposulphite also gives an image containing a less weight of metal than the original, and, besides, is likely to give very complicated unstable images if used sparingly. Ferrous oxalate, on the other hand, is a perfect reagent, leaving every atom of silver in the original image with an atom of mercury added to it.

The most excellent point of this method of intensification is that, so far as I can discover, there is absolutely no loss of even the faintest detail, but a perfect and proportional action throughout. But this very excellence has proved a drawback in the hands of dirty workers, and workers with unclean plates. A silver stain will be intensified as well as the silver image, and must be so if the action is perfect. I know of no failure by this method not due to imperfect washing or other faulty work. But some photographers say they have found alkaline developers, or alkaline developers without the alkali (if the expression will pass), better than ferrous oxalate, and they have recommended these reagents, I am sorry to say, without a knowledge of their action. If they work as they are stated to do, "cleaner" than ferrous oxalate, that is a pretty sure indication that they are less perfect, unless the only difference is due to the precipitation of the lime in the water when oxalate is used. I have tried many of these solutions, and none of them are reliable. By the use of them, mercury that ought to be in the image is lost, and one cannot tell how much mercury will be so lost, nor from what part of the image it will come. It is hardly conceivable that the mercury lost can come proportionately from every part of the image, and if the loss is not proportional throughout, the density gradation of the negative is upset.

Sodium sulphite, when applied alone, removes both silver and mercury from the bleached image, but with a developing agent, whether with or without alkali, I have never found any silver in the solution.

Eikonogen alone I found to act very slightly. With sulphite a great deal of mercury was lost. Eikonogen 12 grains, sodium carbonate 25 grains, and sodium sulphite 25 grains, to water 1 ounce, acted well, but 19 per cent. of the mercury was lost. Metol alone gave no perceptible action. Metol 2 grains, sodium sulphite 4 grains, to 1 ounce, acted well, but very much mercury was lost. Metol 4 grains, sulphite and carbonate 24 grains each, to 1 ounce, acted well, but 32 per cent. of the mercury was lost. Amidol 2 grains and sulphite 20 grains to the ounce worked well, and 10 per cent. of mercury was lost. This appeared hopeful, so I tried amidol 8 and sulphite 20, but this was useless, as its effect was very slight indeed within a reasonable time. So I diminished the amidol instead of increasing it, and tried amidol 1 and sulphite 20. This worked well, but 42 per cent. of the mercury was lost. On mixing the amidol and sulphite, sulphurous acid is set free. By adding ammonia to the mixture a blue color appears when the alkali is in a little excess, and by adding ammonia in quantity, just insufficient to produce this color, a solution may be prepared that will remain slightly alkaline throughout the reaction. Such a solution acts very energetically, but a very large quantity of mercury was dissolved by it. Pyrogallic acid 3 grains, sodium sulphite 8 grains, ammonia 3 minims to the ounce, gave a loss of 29 per cent. of the mercury, and the solution was much more colored than in any other case. Pyrogallic acid with sulphite slightly acidified was no better.

In some cases, as stated above, I have estimated the actual proportion of mercury in the solution, and therefore lost from the image, but these numbers must be taken as only giving a general idea of the amount. In some cases, by prolonging the action a little it would have been increased, and probably in no case would the same loss occur by repeating the experiment.

Thus I am obliged to come to the same conclusion now that I did when I first drew attention to the chemistry of mercurial intensification, namely, that ferrous oxalate is the only satisfactory reagent to follow the application of mercuric chloride. I show an example in which this method of intensification has been carried out on various parts of the same negative, once, twice, three times, and four times, without a suggestion of stain or trouble of any sort. It should be noted that this repeated application of the process is a very severe test of its cleanness when properly carried out. If there had been the slightest false deposit of mercury at any stage, this would have been doubled by the next treatment, and increased to four times and to eight times by successive treatments. Silver would have increased similarly, but to a still greater degree. I could show many negatives intensified by this process, but they are similar in appearance to unintensified negatives and therefore would not be instructive.

There is only one other matter that I will refer to at present, and that but briefly, namely, the getting rid of the hyposulphite from the negative. Experience appears to indicate that if a negative is of a satisfactory density, the small amount of hyposulphite left in it after from two to four hours washing does no harm. But if the negative is to be intensified, any hyposulphite will cause a precipitate of mercury salt, and so give a false deposit. This would, as a rule, matter but little, but for the fact that a gelatine negative is always difficult to wash evenly, and such a false deposit will, therefore, almost always occur in patches. If the gelatine film is of exactly the same thickness throughout, equal washing all over is difficult, but in most plates there are variations in the thickness of the film that make it impossible, unless it is so prolonged as to be practically perfect in the thickest parts. What we want is a reagent that will oxidize the small residue of hyposulphite into sulphate, which is quite inert, without affecting the image or attacking the gelatine. I do not know of any reagent that will do this. Peroxide of hydrogen, as described, appears to be excellent, the general idea being that it produces sodium sulphate and sulphuric acid from the remaining hyposulphite, but this is a mistake. It produces no acid, and only about one-third of the sulphur is oxidized to sulphate. By mixing sodium hyposulphite with a large excess of the peroxide, and allowing them to remain together for three days, less than half the sulphur was changed to sulphate, and whatever change had been produced it was of little, if any, use, for the solution still gave a precipitate with mercuric chloride. Peroxide of hydrogen appears, therefore, to be of no avail; but, even if it were, it would be a very unsafe reagent in the hands of ordinary photographers, because its strength is very liable to decline. It may in a few months be only one-tenth of its original strength, and a bottle freshly opened, though originally without doubt of full strength, may be found to contain only a third of the stated quantity; and these changes lead to no alteration in the appearance of the liquid, and can only be recognized by a direct test. These uncertainties render it of very little use in the hands of those who are unable to estimate its strength. Alum and acids decompose sodium hyposulphite, but a mixture of alum and hydrochloric acid acts very slowly upon a weak solution of it, so slowly that one might be tempted to say that it also was useless. I find, however, that a fairly well washed negative is made more fit for intensification by treating it with an acid solution, or an acidified alum solution, and washing again, and I fancy that the improvement is not due merely to the extra washing that it gets. Whatever may be the actual change brought about by this treatment, I find that it is advantageous from a practical point of view, and that it is a desirable precaution to take.

* *Journal of the Photographic Society*, N. S., xvii., 189

† *Journal of the Photographic Society*, N. S., xviii., 184.

‡ *Photographic Work*, iii., 121.

THE BERLINER PATENT.

THE Harrison International Telephone Company recently obtained opinions from several eminent firms of patent lawyers in regard to the validity of the Harrison and Ford telephone patents, all of the opinions declaring that there is no infringement of the Berliner patent. The opinion of Messrs. Witter & Kenyon is particularly interesting on account of its analysis of the status of the Berliner patent, which is as follows:

"The Berliner patent only covers the use of electrodes that are in constant contact and that operate by variations of the pressure of contact. Your tele-

phone operates by a making and breaking of contact; its electrodes are not in constant contact. The Berliner, like the Bell telephone, throws upon the line wire an undulatory current. Your telephone throws upon the line wire a pulsatory current. Such a pulsatory current was not covered by the Bell telephone patent of 1876, and the United States Supreme Court so decided in the telephone cases. The Berliner patent is no broader in this regard than the Bell patent was. The method of operation of your telephone is thus substantially different from that of the Bell and Berliner telephones. This fundamental difference was, as we understand it, the ground on which the United States Circuit Court in Arkansas refused a preliminary injunction against your company several years ago under the Bell patent, although the injunction was asked for after the United States Supreme Court had sustained that patent. We quote here the two broadest claims of the Berliner patent to show its meaning and scope.

"'1. The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact, so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

"'2. An electric speaking telephone transmitter, operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes in constant contact with each other, and forming part of a circuit, which includes a battery or other source of electric energy, and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.'

"This view of the meaning of the Berliner patent is confirmed by the proceedings in the Patent Office during the fourteen years while this application was pending, which proceedings we have examined; and in our judgment, under all the circumstances of the case, this Berliner patent will be construed by the courts as narrowly and strictly against the Bell Telephone Company and in favor of the public as is possible.

"Again, we are of opinion that the Berliner patent is in any event wholly invalid and void, and will be so declared by the United States courts, either in the pending government suit or in the first suit for infringement that the American Bell Telephone Company may see fit to bring. The same invention was patented to Berliner in an earlier patent, and no one can have two patents for the same invention. The claims of that earlier patent are narrow and do not cover your telephone, but under recent decisions the later patent is wholly invalid.

"Again, the Berliner application, while pending in the Patent Office, was unlawfully and illegally amended in such a way as to strike out from it the real invention which had formed the subject matter of the original application and to interpolate new matter and a new and different invention in fraud of other applicants and of the public—a thing which cannot lawfully be done and which cannot form the basis of a valid patent.

"Again, before the real invention which is now patented in the Berliner patent appeared, even by way of amendment, in the Berliner application, it had been in public use and on sale in the United States for more than two years—a fact which would have constituted a statutory bar to the filing of a proper and lawful application at that time and which now equally invalidates the patent, for the law does not permit the obtaining by indirection of what it bars if openly and properly sought.

"Again, the application was abandoned and forfeited prior to the issue of the patent."

CAUDERAY'S ELECTRIC CLOCK.

NUMEROUS inventors have occupied themselves with the application of the electric current to clockwork. The thing is seductive, in fact, since by this means, while simplifying the mechanism, we dispense with winding, the immediate result of which should be the lowering of the price of the apparatus and the facilitating of the use of it. Yet, up to the present, we have not seen many electric clocks. Aside from their use in a few cities in which an electric distribution of time is made by a central station, independent clocks for private use are not very widely employed. This is probably due to the fact that, in spite of appearances, the systems proposed have hitherto been of too delicate operation or of too high a price; for at present, when there are few houses that are not provided with electric bells and consequently with a battery, there is no reason why the current should not be utilized for operating a chamber clock.

This is doubtless what was thought by Mr. A. J. Cauderay, who has just constructed a very simple and very plain electric clockwork movement capable of operating in any position, and the selling price of which will not exceed a dollar when it comes to be manufactured right along

The system is based upon the principle that in order to make a pendulum swing for an indefinite time it suffices, not to give it a new impulsion after each oscillation, but only at more or less spaced intervals of time. This permits of the use of the battery and electromagnet for keeping up the motion for a very long time without exhaustion of the battery, since the latter furnishes energy only from time to time. It is merely a question of finding the proper moment in which the effect is to be produced.

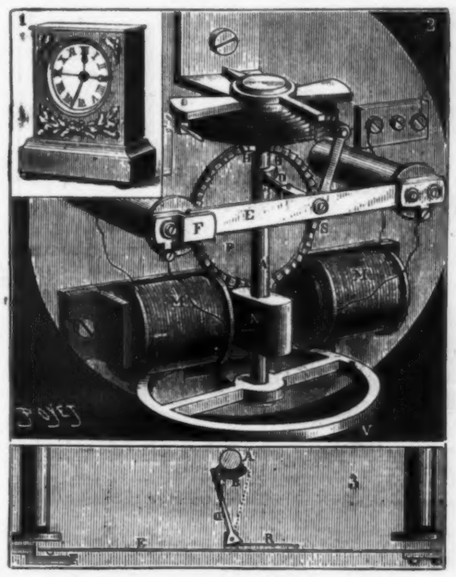
The application of this principle is not new, for Mr. Hipp, of Neuchatel, has for more than twenty years been constructing electric clocks having as a regulator a pendulum kept in motion under such conditions. Upon the same principle also is constructed Mr. Lemoine's "Papillone," and still others.

Mr. Cauderay in nowise lays claim to this idea, but what he has patented is his special application to the spiral balance wheel, which permits of the operation in any position whatever.

The spiral balance wheel, V (Fig. 2), is here at the same time the regulator and the motor. The axis, A, carries at H a detent that acts upon a ratchet wheel, P S, and causes it to move forward by one tooth at each complete oscillation. It is this wheel that carries the seconds hand and that actuates the minute and hour hands through gear wheels.

The motion of the balance wheel is kept up by two electros, M, which attract a small mass of soft iron, N, fixed upon the axis, A. Such action takes place only at the moment in which the oscillations fall beneath their normal value. This result is obtained by means of an ingenious arrangement which is the characteristic of the invention.

The contact that permits the current to pass into the electrodes is located at F, at the end of a flat spring, E (Figs. 2 and 3). In normal time E is distant from F, and the circuit is broken. Upon the spring, E, is fixed a small lever, D, pivoting at one of its extremities and that a small spring, R (Fig. 3), tends to hold at right angles with E. Under the action of the piece, C B, which is fixed to the axis of the balance wheel and follows the oscillations thereof, this lever takes alternately



CAUDERAY'S ELECTRIC CLOCK.

1. General view of the clock. 2. Motive mechanism. 3. Details of the interrupter.

two opposite positions, either that shown in the figure or that shown by dotted lines—but this only on the essential condition that the piece, C B, has a travel sufficient to allow the lever to pass beyond its extremities. If, on the contrary, a half oscillation is too short to allow such condition to be fulfilled, the lever cannot reverse itself, and, at the following oscillation, its extremity will engage with the notch, C. There will then occur a wedging that has the effect of raising the spring, E, when a contact will take place at F, and the action of the electro will permit the oscillation to resume its sway.

It will be seen also from this that if the circuit were broken at any place whatever, the stoppage would always be produced upon the contact, and that, consequently, the motion would be resumed as soon as the circuit was re-established; in other words, the apparatus sets itself in motion without the necessity of a preliminary impulsion by hand.

This has its importance, and shows that Mr. Cauderay's system is capable of serving as a counter of time for determining the duration of any consumption whatever. If it is a question, for example, of an installation of lighting in which the number of lamps lighted is always the same, the discharge being constant, it will suffice, in order to have the output, to know the duration of the lighting.

Such a result will be obtained by branching the apparatus in derivation upon the general line of wires. In this case it is clear that one will have made arrangements for actuating a totalizer instead of a dial train. Such application can be extended in all analogous cases of a constant discharge, electric or otherwise, since it suffices simply to close a circuit at the moment at which the consumption begins.

Up to the present, Mr. Cauderay has applied his system only to a clock (Fig. 1) which contains in its base two dry batteries of a model widely used in England, and that permit of the operation for several months.

If one has at his disposal another source of electricity, as, for example, that of call bells, it can be utilized instead of having recourse to special batteries. This permits of never having to occupy one's self with the clock.

In the movement that we have had in hand, the oscillations of the pendulum kept up for ten seconds, after which the electric action intervened to give a new impulsion. A small lever acting upon the spiral permits, as in watches, of regulating the regular motion of the hands. It would be possible, however, for a clock of precision to have a compensating balance wheel.

Upon the whole, the system devised by Mr. Cauderay is of simple construction and reasonable in price and is capable of receiving numerous applications. As now applied to clockwork, it constitutes a very interesting application of domestic electricity.—*La Nature.*

WIRE-NETTING MACHINE.

WE illustrate from *Engineering* a neatly designed wire-netting machine made by Wilmott Brothers & Cobon, London, S.E. In machines of this type two sets of wires are used, and the net is produced by the intertwisting of these sets with each other. One set of the wires is coiled up very closely and packed in a series of vertical tubes which are clearly shown in Fig. 1. From the top of these tubes the wires pass out to a roller on which the finished net is coiled. The other set of wires is carried on bobbins fixed at the bottom of the machine. From these bobbins the wires are led up parallel to the aforesaid tubes, and pass through hollow spindles, on a level with and opposite to the tops of the tubes, to the roller already mentioned. Considering one wire of one set and one of the other, it will be seen that by making the tubes rotate round the wires from the bobbins, the wires of one set will be twisted round those of the other. This having been done, the hollow spindles are shifted laterally so that each comes opposite the tube immediately adjoining the one it was previously opposite. If the tubes are each again caused to rotate round the wire now opposite to it, the two sets of wires will again be intertwisted, thus forming half a mesh, which is completed by shifting back the bobbins to their previous position, and again causing the tubes to rotate round the wires. To effect this rotation the top of each tube has half a pinion keyed to it, while the hollow spindles are similarly fitted. When a spindle is opposite a tube the two half pinions form a complete one, which by means of a rack moved horizontally by the crank shown in Fig. 1 is caused to rotate. Thus the hollow spindle and the tube move round each other, twisting together their respective wires as already explained. One twist

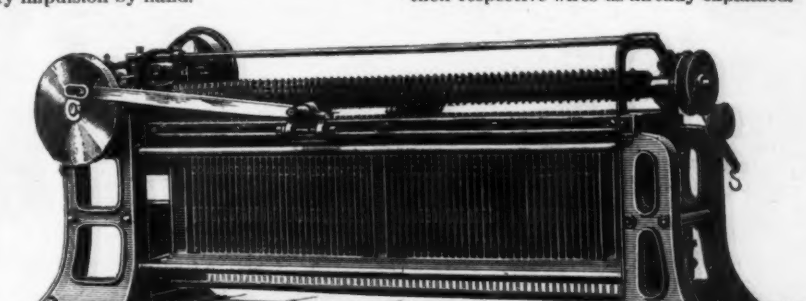


FIG. 1.

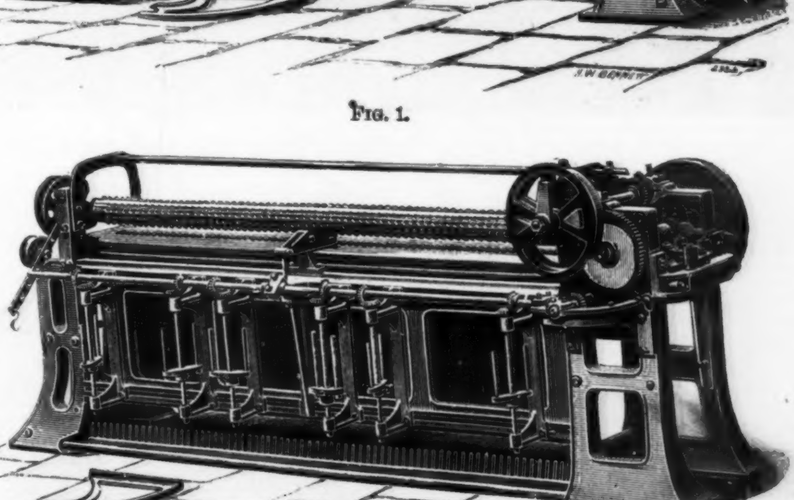


FIG. 2.

MACHINE FOR MAKING WIRE NETTING.

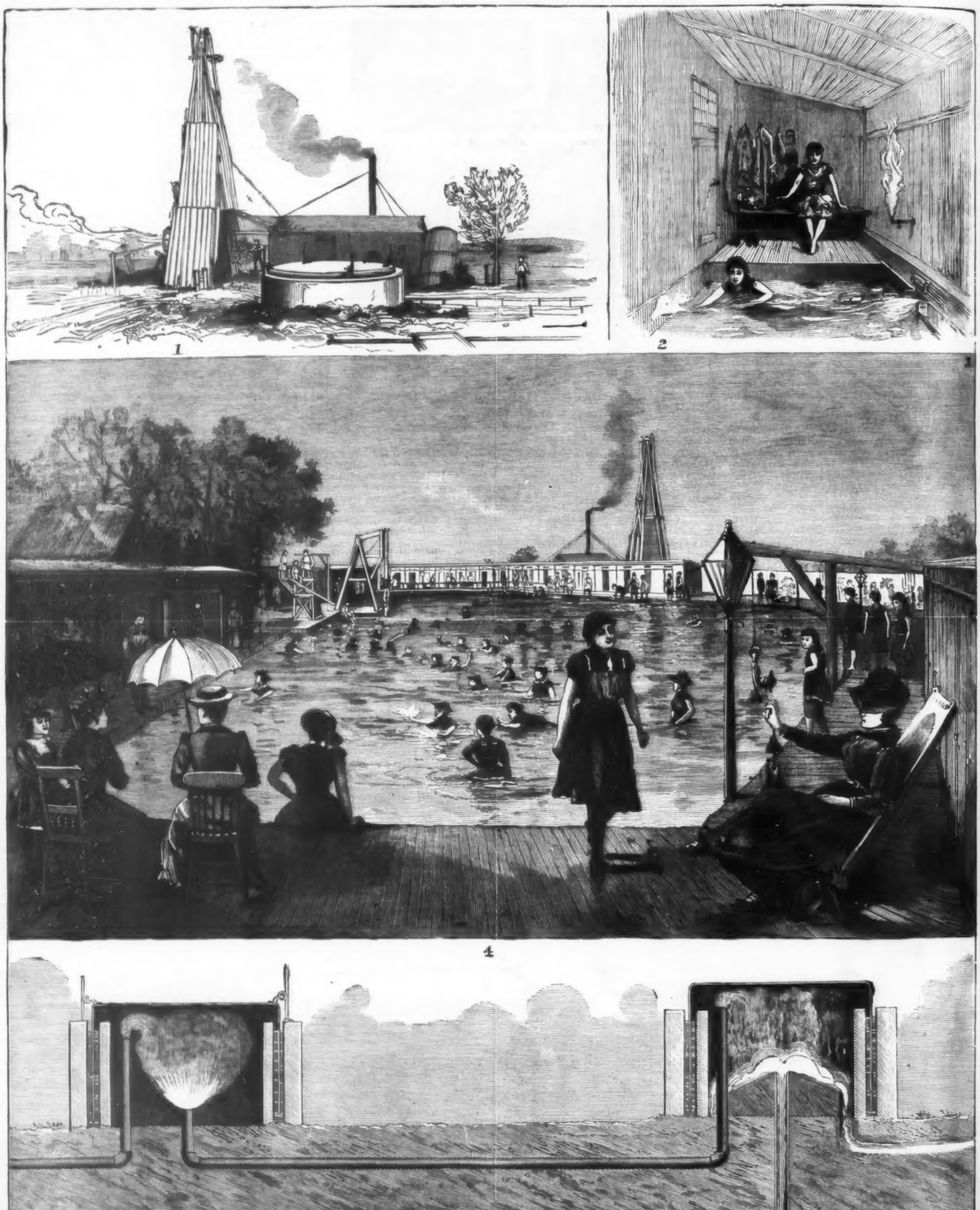
having been completed, the spindles are shifted laterally by a cam motion, so that the half pinion is now fellow to that on the adjoining tube, under which conditions the completed pinions are again rotated by the rack as already explained. The pinions in question can be seen in Fig. 2, which is a back view of the machine. Our description of this machine is based upon that of Mr. J. Bucknall Smith, C.E, in his work on "Wire; its Manufacture and Uses."

THE STOCKTON WARM WATER BATHS.

THERE are scattered over this country a large number of natural mineral springs whose waters vary, both as to temperature and constituents, to such an extent as to adapt them as curatives to almost every disease human flesh is heir to, and it is a curious fact that we find in the United States springs that correspond in almost every particular to the noted springs in Europe. We also have many artesian wells yielding mineral waters differing widely in chemical composition and varying in temperature from 47° to 184°. Some of these wells were bored with the expectation of finding mineral waters, but the most of them were put down for the purpose of obtaining pure water, petroleum or gas.

At Stockton, Cal., there is an artesian well 1,700 feet deep, from which flow 2,250 gallons of water a minute. In addition to this large flow of water, the well yields 75,000 feet of illuminating gas daily. The well was bored for natural gas, but the water, on account of its pleasant temperature and medicinal properties, was found to have great value for the purposes to which it is applied.

The water issues from the well at a temperature of 86° F., and supplies a miniature lake varying in depth from a few inches to 10 feet. This lake, which is about 400 feet long and 80 feet wide, is fitted up as an immense swimming bath and is surrounded by 115 dressing rooms. The water being continually renewed by the flow from the well, the temperature of the lake is maintained between 80° and 86°. Bathers at this



1. New well and gasometer. 2. Covered baths. 3. The lake. 4. Separating tank and gasometer.

STOCKTON, CAL.—WARM WATER WELLS AND NATURAL GAS.

place derive great benefit from baths in this water, and draughts of it prove beneficial. Analysis shows it to be impregnated with common salt, soda, magnesia, iron, and sulphur. Fish are often seen jumping from the surface of the lake. Several varieties have been caught there by our own artist, who made the accompanying sketches. It is supposed that the fish find their way into the water of the lake through the overflow.

Our engraving shows the separator by means of which the water flowing from the well is separated from the gas and directed to the lake. The gas is conveyed to a gasometer, from which it is distributed for lighting and heating purposes. A second well is being drilled, but up to the present time the only yield from this well is gas. It is thought that the absence of water is owing to its proximity to the first well. However, the work is being pushed still further, with the expectation of finally striking a good flow of water.

When the out of door temperature is too low to permit of bathing in comfort, bathers resort to the covered baths, the air of which is heated by a jet of natural gas burning freely in the room, as shown in one of the engravings.

It is stated that as many as 1,000 bathers can be accommodated daily at this place. In addition to the large bath and the inclosed baths, there are twelve private bath rooms containing large tubs, and other rooms containing bath tubs for children too small to be taken into the lake.

This place has become a great resort not only of the citizens of Stockton and the surrounding country, but of people from distant places who visit the place as much for pleasure as for the beneficial effects of the mineral water. These baths are probably the most popular inland resort on the Pacific coast.

THE ADULTERATION OF FOOD.*

By H. W. WILEY, Chemist of the United States Department of Agriculture.

BARNUM made a colossal fortune by acting on the principle that Americans like to be humbugged. There is something soothingly seductive in being led to the circus by lurid posters showing unattainable attitudes of impossible monsters. This attractiveness is increased by the knowledge that, like the limited express, it implies an extra charge. The public would rise with unanimous execration were it to attend a circus where side shows were not known and the *post ludum* concerts were free. Were the feats of legerdemain of the mystic Hermann actual performances of supernatural powers, they would lose for us half their charm. To be cheated, fooled, bamboozled, cajoled, deceived, pettifogged, demagogued, hypnotized, manicured and chiropodized are privileges dear to us all. Woe be to that paternalism in government which shall attempt to deprive us of these inalienable rights. There is no point on which the average American is more sensitive in respect of legal restriction than in those instances in which law interposes to prevent him from making a fool of himself. Only after a long struggle has a distinguished citizen of your city, now in public life, been able to prevent the mails from paying the expenses of the delta of the Mississippi. Only the other day, in New Orleans, I read in the lottery advertisement that the ticket drawing the last capital prize of $75,000 had been sold in Washington, Philadelphia and Kalamazoo. This all doubtless comes from the fact that in this country each one of us is just as good as the next, a condition of affairs which, in true Gilbertian humor, has been touched off in the distich:

"When everybody's somebody,
Nobody's anybody;"

therefore, we should not be surprised at the pertinent inquiry of why A, being no better than B, should interfere with B when B wants to get drunk or buy a lottery ticket.

In regard to the character of what we eat and drink, we find the same unwillingness to be watched over and protected.

A few days ago in Chicago I went out to the Union Stock Yards to look at the process of meat inspection. From each carcass of pork intended for exportation is taken a sample of the flesh and this is carefully examined for trichinæ. "Do you often find diseased samples?" I asked. "Yes," said the attendant; "from one to two per cent. of all the samples examined is found infected." "Could I see a sample of that kind?" "Certainly. Has any one a trichinosed sample in the microscope?" A pretty girl microscopist held up her hand. I looked and saw for myself the curled and coiled serpent ready for a strike. How I congratulated that lucky sarcophagous Teuton who had been saved from a horrid death by the fairy fingers and sure blue eyes of the trichinæ girl. "What do they do with these infected carcasses?" A shrug of the shoulders led me to believe that they were sent to soap factories, as they doubtless are, and this was followed by the expression, "But Americans don't eat raw pork," and I am led to suppose from this that trichinæ are really very good and nice when well broiled. Next morning, when I ordered ham for breakfast, I asked the waiter to have it cut thin and broiled crisp. Even then when it was brought in I could not help thinking that it looked like a bretzel.

That distinguished jurisconsult and patriot, Senator Paddock, of Nebraska, during the first session of the present Congress, after years of futile struggle, succeeded in having the Senate pass what is known as the Pure Food bill, but it seems from the provisions of this bill that the Congress of the United States has only power to protect the foreigner, the disfranchised and the Indian not taxed. The provisions of the bill are confined to the Territories and the District of Columbia and to interstate commerce. Mild as are the penalties of the bill, allowing the citizens of any State to make a dessert and call it peas if they like, yet it has been left unpassed in the House of Representatives.

The Paddock Pure Food bill, to summarize it briefly, has for its purpose the protection of commerce in food products and drugs between the several States, the District of Columbia, the Territories of the United States and foreign countries, and the Secretary of Agriculture is authorized to make the necessary rules for carrying out the objects of the bill. He is authorized to cause to be punished, through the proper courts, any one introducing in any State or Territory or the District of Columbia or from any foreign country any article of food or drugs which is adulterated or misbranded. The act says that the term "food" shall include all articles used for food or drink by man, whether simple, mixed or compound. In the case of food or drink, an article shall be deemed to be adulterated if any substance or substances has or have been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength, so that such product when offered for sale shall be calculated to deceive the purchaser; further, if it contain any inferior substance or substances substituted wholly or in part for the article, or if any valuable constituent of the article have been wholly or in part abstracted, or if it be an imitation of and sold under the specific name of another article, or if it be mixed, colored, powdered or stained in a manner whereby any imperfection therein shall be concealed, or if it contain any added poisonous ingredient or any ingredient which may render such article injurious to the health of the person consuming it. Further, the food is declared to be adulterated if it consist of the whole or any part of a diseased, filthy, decomposed or putrid animal or vegetable substance or any portion of an animal unfit for food, provided that an article of food shall not be considered adulterated if it be a mixture or compound sold under its own distinctive name, or an article labeled, branded or tagged so as to plainly indicate that it is a mixture, compound, combination or blend.

It will be seen by the above provisions that the bill is very far reaching in its character, and it contains also the proper penalty for enforcing its operation. This bill passed the United States Senate on March 9, 1892. Mr. Paddock, in concluding his speech in advocacy of the bill, used the following words:

"In the name and in the interest of public morality, I appeal to you to set legislative bounds, beyond which the wicked may not go with impunity in this corrupt and corrupting work. Let us at least attempt to perform our part in the general effort to elevate the standard of commercial honesty which has been so disgracefully lowered by these deceptions, frauds and robberies, the malign influence of which is everywhere present, everywhere felt.

"Let us help by our action here to protect and sustain in his honorable vocation the honest producer, manufacturer, merchant and trader, whose business is constantly menaced and often ruined by these unscrupulous competitors, who by their vile and dishonest arts, manipulations and misbrandings are able to make the bad and impure appear to be the pure and the genuine; thus, by a double deception, both as to quality and price, making the worse appear the better choice to the unintelligent mass of purchasers.

"In the interest of the great consuming public, particularly the poor, I beg of you to make an honest, earnest effort to enact this law. At best a great multitude of our people are oppressed by a fear, a never absent apprehension, which they carry to their work by day, and to their beds by night, that perhaps at the end of the following day, or week, or month, their ends may fail to meet. Under the strain of this grim menace life itself becomes a burden almost too grievous to be borne. But the thought of helpless wife and children, whose sole dependence he is, renews the courage of the wage worker from day to day, and so he struggles on, praying and hoping to the end.

"These, Mr. President, are the men, and these the women and children, for whom, before all others, I make this appeal. If you could save to these the possible one-third of the nutritious element of their food supplies which is extracted to be replaced by that which is only bulk, only the form and semblance of that of which they are robbed by the dishonest manipulator and trader, you would go a long way toward solving the great problem of the laboring masses—whether for them it is "better to live or not to live," whether it is better to bear the ills they have, rather than fly to others that they know not of, that lie beyond in the realm of governmental and social upheaval and chaos.

"There is a good deal in the way of comic 'asides' as the momentous social drama which holds the boards at this time, and whose *dramatis personæ* are the so-called common people, rapidly advances to the epilogue. Be not deceived! the storm doth not abate. It is ever rising. Its violence is ever increasing. Take heed when the people demand bread that you continue not to give them a stone, lest the angry waves of popular discontent may some time, perhaps in the near future, rise so high as to overwhelm and engulf forever all that we most greatly value—our free institutions, and all the glories and hopes of our great republic—which are not ours alone, but which belong—and, if they are preserved and shall permanently endure, will be an ever continuing blessing—to all mankind."

This pure food bill has received the unanimous support of nearly every agricultural organization in the United States. It has been opposed by a number of manufacturing establishments interested in the production of drugs and mixed foods, and also by those largely interested in the manufacture of substitutes for lard. If adopted, it can at once be seen that it would do away with the necessity of the oleomargarine law, which is a special form of legislation and, like all special legislation, must be open to many objections.

As before stated, the national law, as indicated above, does not protect the citizen of any State against an adulterated food which is manufactured and sold within the State. Such police power must be left wholly to the several States. Many of the States already have laws on their statute books dealing with the subject of food adulteration. These laws, however, are for the most part inoperative, and, not being based on a common plan, would naturally not secure, even when fully enforced, the same degree of protection in all States. What is needed for a complete legal protection of the people against adulterated foods is not only the enactment of the Paddock pure food bill, but a similar enactment of a similar scope and aim for each of the several States.

Among the various States which have laws on the subject may be mentioned Illinois, which has an act to prevent and punish the adulteration of articles of food, drink, and medicine, and the sale thereof when adulterated. There is also a special law preventing the adulteration of butter and cheese.

Iowa has a statute, entitled an act to prevent deception in the manufacture and sale of imitation butter and cheese. One of the provisions of this law is that no keeper of a hotel, boarding house, restaurant or other public place of entertainment shall knowingly place before any patron, for use as food, any imitation butter or imitation cheese unless the same be accompanied by a placard containing the name in English of such article printed in plain Roman type. Iowa also has a special law in regard to the adulteration of milk.

Maine has a food law to prevent the manufacture and sale of adulterated lard. Maine also has a general law on the adulteration of food and drinks.

Maryland has a statute to provide for the prevention of the adulteration of articles of food and drink and the sale thereof when adulterated or unwholesome. The enforcement of this law is placed largely in the hands of the State Board of Health.

Perhaps the best of the State laws concerning adulteration are those of Massachusetts, the statutes of which provide that "no person shall, within this commonwealth, manufacture for sale, offer for sale, or sell, any drug or article of food which is adulterated within the meaning of this law." The law of Massachusetts is, in all essential particulars, that of the Paddock Pure Food Bill, of course with such variations as are necessary in the enactment of a State law as compared with a federal law. The law of Massachusetts is especially effective as regards the sale of adulterated milk and other adulterated food and has a system of State inspection which has already reduced the percentage of adulteration of such articles to a very low figure. Monthly returns are made by the inspectors and analysts of foods and drugs. The report for the month of October, which is the latest one, contains the results of the inspection of milk, butter, cheese, olive oil, vinegar, spices, cream of tartar, molasses, maple sugar, maple sirup, honey, tea, coffee, confectionery and miscellaneous articles and drugs. The total number of samples examined was 610; the number found to conform to the legal standard was 428, and the number of samples varying from the legal standard, that is, adulterated within the meaning of the act, 182. The percentage of the adulteration was 29·8. The actual percentage of adulteration is very much less than this, for it is only suspicious articles of food to which the attention of the board is directed. Certain staple products, such as sugar, flour, and the various cereal products, are very rarely adulterated and receive but little inspection. The work of the board is, therefore, mainly devoted to the inspection of such articles as have been found, by several years of experience, to be especially liable to adulteration. Eleven actions were brought in the courts during the month for violation of the food and drugs act. Five were for the violation of the statute relating to the sale of milk; two of coffee; one each of honey, cream of tartar, cloves and pepper. In all of the eleven cases conviction followed and fines of $247 in all were imposed. The cities and towns from which samples of food were collected during the month were Boston, Worcester, Lowell, Cambridge, Springfield, Lawrence, Somerville, Salem, Chelsea, Malden, Newton, Taunton, Waltham, Pittsfield, Brookline, Charlton, Greenfield, Hyde Park, Lee, Marblehead, Milton, Natick, North Adams, Orange, Stoneham, Stoughton and Ware.

The case of Massachusetts is given somewhat at length on account of the excellence of the system of inspection. It shows what a State law can accomplish when wisely made and honestly enforced. In the one item of milk alone, it would be difficult to estimate the amount which has been saved to consumers by the strict enforcement of the law which requires the milk sold to contain a certain amount of total solids and fat.

Time remains only to mention the other States which have laws of some kind on the subject of adulteration. These States are Michigan, Minnesota (which has a series of good laws, both special and general), New Hampshire, New Jersey (which also has a good system of laws), New York, Ohio (also with a fairly good system) and Pennsylvania, which divides its law into three sections; the first relating to liquors, I suppose because this is the most important of the foods of this State; the second to food adulteration in general, and the third especially to dairy products. The weakness of the Pennsylvania law is not so much in the character of the provisions relating to the sale of foods as in the method of securing their enforcement. It does not provide for any system of inspection as does the law of Massachusetts; and no law relating to the adulteration of food is of any value whatever as a protection to the community unless a rigid system of constant inspection is provided for. The Pennsylvania law declares that the addition of water or of ice to milk is an adulteration, and any milk obtained from animals fed on distillery waste is declared to be impure and unwholesome. The removal of the cream is also declared an adulteration. The law prevents the manufacture of any substance provided to take the place of pure butter fat. This is not a restriction on the sale of an adulterated butter, but is a total prohibition of the manufacture and sale of any substitute for butter, even if it be sold under its own proper name.

Continuing the list of States with laws against the adulteration of food, we have next Virginia and Wisconsin. The latter State has a very good law, which not only has a general provision but also enters into detail, especially in regard to dairy products, describing what shall be considered pure milk, or establishing a standard thereof, and stating how an adulteration of milk shall be proved, and how adulterated honey shall be marked. It contains penalties for the sale of unwholesome provisions and items in regard to the adulteration of foods and drugs, fraud in dairy manufactories, the form of label to be placed on dairy products, the strength of vinegar, etc.

(*To be continued.*)

* A lecture delivered before the Franklin Institute. From the *Journal of the Institute*.

ON CHEMICAL LABORATORIES.*

By Ira Remsen.

On January 1 the Kent Chemical Laboratory was dedicated with appropriate exercises. The beautiful building was thrown open to inspection, and many passed through its rooms expressing admiration. Its plans were explained and a general account was given of the uses to which it is to be put. Honor, "as is most justly due," was paid to the generous donor, whose name from this day forth will be intimately associated with progress in chemistry in this country. The exercises of yesterday have led by an easy step to those of to day, and a chemist is called upon to give the convocation address. What theme more natural to him, or more appropriate, than "The Chemical Laboratory"? It is to this theme that I ask your attention. My purpose is to treat the chemical laboratory, not from the material point of view, but in its broader aspects, as far as I may find this possible. I shall attempt to answer briefly three questions, and these are:

1. When and how did chemical laboratories come to be established in universities?

2. What part have chemical laboratories played in the advancement of knowledge?

3. What are the legitimate uses of the chemical laboratory of a university at the present time in this country?

The first laboratory ever erected for the teaching of chemistry—indeed, the first laboratory for teaching any branch—was that of the University of Giessen, Germany, which owed its existence to the enthusiasm of Liebig. The story is an interesting one, and especially instructive on an occasion such as this. Liebig was born in the year 1803. According to his own account, he had a hard time of it in the schools. He says: "My position at school was very deplorable. I had no ear memory, and retained nothing or very little of what is learned through this sense. I found myself in the most uncomfortable position in which a boy could possibly be; languages and everything that is acquired by their means, that gains praise and honor in the school, were out of my reach; and when the venerable rector of the gymnasium, on one occasion of his examination of my class, came to me and made a most cutting remonstrance with me for my want of diligence—how I was the plague of my teacher and the sorrow of my parents, and what did I think was to become of me—and I answered him that I would be a chemist, the whole school and the good old man himself broke into an uncontrollable fit of laughter, for no one at that time had any idea that chemistry was a thing that could be studied."

This was truly an unpropitious beginning, yet this butt of his school was soon contributing more to the development of chemistry than any one ever had before or than any one ever has since. Filled with the determination to study chemical things and phenomena, he left the school where he had been such a failure, and entered an apothecary shop, but at the end of ten months the proprietor was so tired of him that he sent him back to his father. As Liebig said, he wanted to be a chemist, not a druggist. He must have been about fifteen years of age when, in spite of his inadequate preparation in languages, he was received as a student in the University of Bonn, and from here a little later he went to Erlangen. But he appears not to have been much better satisfied at the university than he was in the apothecary shop. He speaks almost with contempt of the teachers under whom he studied. "It was then a very wretched time for chemistry in Germany," he says. "At most of the universities there was no special chair of chemistry; it was generally handed over to the professor of medicine, who taught it, as much as he knew of it—and that was little enough—along with the branches of toxicology, pharmacology, materia medica, practical medicine, and pharmacy." Referring to the equipment of the universities for the teaching of chemistry, he says: "I remember, at a much later period, Prof. Wurzer, who had the chair of chemistry at Marburg, showing me a wooden table drawer, which had the property of producing quicksilver every three months. He possessed an apparatus which mainly consisted of a long clay pipe stem, with which he converted oxygen into nitrogen by making the porous pipe stem red-hot in charcoal, and passing oxygen through it. Chemical laboratories, in which instruction in chemical analysis was imparted, existed nowhere at that time. What passed by that name were more like kitchens fitted with all sorts of furnaces and utensils for the carrying out of metallurgical or pharmaceutical processes. No one really understood how to teach it."

After a comparatively short sojourn in Erlangen, Liebig returned home, fully persuaded that he could not attain his ends in Germany. Some of the young men of that time had gone to Stockholm to study chemistry, attracted thither by the fame of the great Berzelius. But Liebig decided in favor of Paris. He was then seventeen and a half years old, and, as we have seen, he could not have been well prepared in chemistry, yet in a short time after his arrival, he made such an impression on Alexander von Humboldt that he was admitted to the laboratory of one of the most brilliant chemists of the day, Gay-Lussac. He had previously begun an examination on certain fulminating compounds to which his attention was first directed in a curious way at his home in Darmstadt.

Let me again use his own words: "In the market at Darmstadt I watched how a peripatetic dealer in odds and ends made fulminating silver for his pea crackers. I observed the red vapors which were formed when he dissolved his silver, and that he added to it nitric acid, and then a liquid which smelt of brandy, and with which he cleaned dirty collars for the people." Gay-Lussac gladly joined him in the investigation, and he gratefully refers to this opportunity. He acknowledges that the foundation of all his later work was laid in Gay-Lussac's laboratory.

And now to the main point. When Liebig was in his twenty-first year he received an appointment to a professorship of chemistry at Giessen through the influence of Von Humboldt. His opportunity had come. He determined to have a laboratory for teaching. The great advantages he had reaped from his contact with Gay-Lussac showed him clearly that if students were to study chemistry at all, it must be in a well equipped laboratory in contact with a teacher. And so the first laboratory was built, and became one of the great forces of the world. Soon students flocked to the little university from all parts of the civilized world, and the most flourishing and powerful school of chemistry that has ever existed was rapidly developed. One of the most brilliant pupils of this school, the late Prof. Hofmann, of Berlin, in speaking of its influence, says: "The foundation of this school forms an epoch in the history of chemical science. It was here that experimental instruction such as now prevails in our laboratories received its earliest form and fashion; and if, at the present moment, we are proud of the magnificent temples raised to chemical science in all our schools and universities, let it never be forgotten that they all owe their origin to the prototype set up by Liebig." The foundation of this school marked an epoch not only in the history of chemical science, but in the history of science. The great success of this laboratory led naturally to the building of others, and in a comparatively few years a chemical laboratory, at least, came to be regarded as essential to every university. At first these were of necessity modest affairs. One of the earliest was that at Tubingen, in regard to which a curious fact may be mentioned. It appears that the ground available for Liebig's laboratory in Giessen was not altogether well adapted to its purpose, and in consequence one of the larger working rooms received light from only one side. When the laboratory at Tubingen was built later, that at Giessen was copied in every detail, even to the dark room, notwithstanding the fact that there were no buildings in the immediate neighborhood, and light in abundance was available.

As time passed, the era of the palatial laboratory was introduced. Probably we shall be very near the truth if we fix the responsibility of this era upon Bonn. Hofmann was called to Bonn from England, whither he had gone under the most flattering conditions, and before accepting the new call, he had, no doubt, received promises with reference to a laboratory. At all events, a building was erected much finer than anything in the way of a laboratory that had ever appeared. As is customary in Germany, the professor's dwelling rooms were in the building, and so beautiful were all the arrangements, that when the King of Prussia passed through at the time of the formal opening, he is said to have remarked, "I should like to live here myself." Soon after this Hofmann built the laboratory at Berlin, and again magnificence was the order of the day. Statues and carvings, and tiles and frescoes, took their place in the laboratory, and since then in Germany and France and Austria and Switzerland immense sums have been expended in the erection not only of chemical but of physical and physiological and petrographical, and anatomical, and pharmacological, and geological laboratories. While of late years there has perhaps been a reaction, and a tendency to somewhat simpler buildings than those that at one time were the fashion, it is still true that the laboratories are semi-palatial, and a strict economist might find ground for complaint, claiming that results as good might have been obtained at smaller cost. It would hardly be profitable to discuss this point here. In this country we cannot be said in general to have been extravagant in building laboratories; certainly not, if we keep the European standard in mind. Most of the larger laboratories in this country are modest in their fittings, and the strictest economist could hardly find fault.

If we had the power to estimate the value of the work that has been done for the world by the scientific laboratories, it is certain that the money spent for them, however great the sum may be, would appear to us ridiculously small. The scientific method, as it is called, has been spread among men, and has changed the whole aspect of things. The influence of the laboratory is felt in every branch of knowledge. The methods of investigation have changed, and everywhere the scientific method has been adopted. Who can tell what an enormous influence this has already had upon the thoughts and actions of men, and what still greater influence is to be exerted? The laboratory has impressed upon the world the truth that in order to learn about anything it will not suffice to stand aloof and speculate, and that it is necessary to come into as close contact with that thing as possible. When the old philosopher wished to solve a problem, his method was to sit down and think about it. He relied upon the workings of his brain to frame a theory, and beautiful theories where undoubtedly framed, and many of these, probably all of those which had reference to natural phenomena, were far in advance of facts known, and often directly opposed to facts discovered later. Minds were not hampered by facts, and theories grew apace. The age was one of mental operations. A beautiful thought was evidently regarded as something much superior to knowledge. We have not learned to think less of beautiful thoughts or of mental processes, but we have learned to think more of facts, and to let our beautiful thoughts be guided by them.

And how did this come about? It is curious that the scientific method of work, which is altogether the simplest, should be the last to be adopted by the world, as it is by individuals. It would be impossible to determine all the causes that have led to this result, but one of the immediate causes is undoubtedly to be found in the fact that, at an early period in the history of the world, those who worked with their hands came to be looked upon as inferior to those who worked with their heads alone. This operated powerfully to keep those who were best fitted to advance knowledge from adopting the simplest method, viz., that of studying things. One who engaged in experiment did it surreptitiously, or lost caste.

Probably the most powerful force that first led men to experiment systematically was the conception of the philosopher's stone, and out of the labors of the alchemists sprang experimental science. Strange as it may seem, it was the love of gold that led to the development of scientific methods of investigation. In some way, probably through superficial observations, men came early to think it possible that the ordinary or base metals could be transformed into gold, and with this idea came the desire to experiment on the subject, and the experiments on this subject have been kept up until the present century. So that in one sense, certainly, it is not true that "the love of money is the root of all evil." While much folly was committed in the name of alchemy—as much folly is committed today in the name of chemistry, and of medicine, and of other lines of work—it is clear that the true alchemist was as ardent a worker as the world has perhaps ever seen; he was engaged in experimenting. He was teaching the world that the way to a correct knowledge of nature lies not in philosophy alone but through coming in contact with things of nature, and becoming personally acquainted with them. Paracelsus speaks of the alchemists of his time thus: "They are not given to idleness, nor go in a proud habit, or plush or velvet garments, often showing their rings upon their fingers, or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labors, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratory. They wear leather garments with a pouch, and an apron wherewith they wipe their hands. They put their fingers among coals, and into clay, not into gold rings. They are sooty and black like smiths and colliers, and do not pride themselves upon clean and beautiful faces."

This is certainly the picture of a hard worker, and as such we must look upon the alchemist. The work done by the alchemists was chemical work. It was allied very closely to the work done by chemists nowadays. They hoped to find the philosopher's stone among chemical substances, and the transformation they hoped for was to be accomplished by a chemical method. They consequently devoted themselves to careful study of all known chemical substances, and in further studying the action of these substances upon one another they came into possession of new facts. There can be no doubt that we owe to the alchemists not only the foundation of chemistry, but the foundation of experimental science. In our superior way we smile at their futile labors to discover the philosopher's stone, but the tremendous results reached by them must not be lost sight of. The theory of the philosopher's stone was shown to be false theory; but what of that? Probably many of the theories now held are false, but they are none the less valuable. An idea is of value if it leads to active work. Working hypotheses are the stepping stones of intellectual progress. The philosopher's stone was more than a stepping stone—it was a magnificent bridge. "Any idea," says Liebig, "which stimulates men to work, excites the perceptive faculty, and brings perseverance, is a gain for science, for it is work that leads to discoveries. The most lively imagination, the most profound wisdom, is not capable of suggesting a thought which could have acted more powerfully and lastingly upon the mind and powers of man than did the idea of the philosopher's stone. Without this idea chemistry could not exist to-day in its present perfection."

Let us now turn from the past to the present, and inquire, What is the province of a chemical laboratory in a university in this country? The first chemical laboratories had for their sole object the training of chemists, and consequently, the methods adopted in them were adapted to this end alone. Afterward, and indeed only quite recently, the importance of laboratory training in chemistry for those looking forward to the study of medicine came to be recognized; and, still later, the idea that such training might be made a valuable part of a general education appeared. At present, then, a chemical laboratory is called upon to furnish opportunities (1) for the general student who does not expect to become either a technical chemist or a teacher of chemistry; (2) for the medical student; (3) for him who expects to devote himself to the practice of chemistry, either in a chemical factory or in an analytical laboratory; and (4) for him who is to devote his life to teaching and investigation. In addition to furnishing these opportunities, it should also be a place in which investigation is constantly carried on by the teachers and advanced students.

As regards the teaching of chemistry to general students much might be said, but it will be possible to touch upon only a few points on this occasion. Most of the teaching is of this kind, and the subject is under active discussion. There can be no question that much of the work done in schools and colleges is highly unsatisfactory, many of the courses which are called scientific are most unscientific, and the student is often more harmed than benefited by his work. If a course in a science, whatever that science may be, does not tend in some degree to develop a scientific habit of mind in the student, it is not serving its legitimate purpose. If the experience of twenty-one years in teaching in college and university in this country is worth anything, your speaker, who has during that time had to deal with many students from all parts of the country, is justified in asserting that the minds of students who enter college are very far from being scientific, and the same can be said of most of those fresh from the colleges. By a scientific mind is meant one that tends to deal with questions objectively, to judge things on their merits, and that does not tend to prejudge every question by the aid of ideas formed independently of the things themselves. Perhaps an anecdote, though trivial, will make this clearer. In a book used by my classes for a number of years there was one error that served as a simple test of the condition of the students' minds. In the directions for performing a certain experiment, the statement was made that a blue solution would result at one stage. As a matter of fact, the solution referred to was always a bright green. Each student being required to write out an accurate description of what he had seen, each one in turn for a series of years described the green solution as blue, disregarding the evidence of his senses, and accepting the evidence of the printed word as more reliable. Occasionally one would appear whose conscience was troubled by the discrepancy, and who would boldly assert that the book must be wrong, but the number of these exceptions was insignificant. Surely this tendency to disregard the evidence of the senses is one that in the great majority of cases can be overcome. It would be better if it did not exist at all, and it probably would not exist if our educational methods were what they should be. We need teachers properly trained for carrying on scientific

* Address delivered by Prof. Ira Remsen on January 2, 1894, in connection with the opening of the Kent Chemical Laboratory of the University of Chicago, U. S. A.

courses in our schools and colleges, and one of the most important branches of work in a university is the training of such teachers. Many of the courses in schools and colleges are at present too ambitious. The attempt is made in them to do in a small way just what is done in a large way in the most advanced courses in the universities. Instead of being what they should be, school courses and college courses, they are reduced university courses. Young men who have had the advantages of advanced courses feel so plainly the benefits they have received, that they naturally wish their own students in turn, whatever their ages may be, to get the same benefits. But time will not permit further discussion of this topic, and the main object in referring to it at all is to make it clear that the university laboratory has a great field of work in connection with the improvement of methods of teaching chemistry.

The teaching of chemistry to medical students suggests a number of thoughts, but they are rather of a special character, and this branch of our subject may be passed over with the remark that there is practical agreement as to this point, that what the medical student most needs at first is good scientific training, and that a course in general chemistry is well suited to this purpose. The most recently established medical schools require training in chemistry as one of the conditions of matriculation, and it is distinctly understood that it is chemistry, and not medical chemistry nor physiological chemistry, that is wanted.

The relation of the science of chemistry to the chemical industries is suggested by the next division of the subject. Here a most instructive object lesson was afforded during the past summer by a visit to the chemical exhibits in Jackson Park, where for the time being the products of the earth were concentrated. If you had had an intelligent chemical guide, he would have pointed out many an interesting product from England, France, Russia, Italy, and this country, but his enthusiasm would have been reserved for the exhibit of the German chemical industries. He would have pointed out a great variety of beautiful and valuable products, and you would, I am sure, have carried away with you the conviction that the Germans excel the world in this line of work. The reason is not hard to find. It has often been discussed, but it would not be right to let this opportunity pass without again calling attention to it. Those who are familiar with the subject do not hesitate to acknowledge that the reason why the chemical industries have reached such a flourishing condition in Germany is that the pure science has been so assiduously cultivated. The value of pure science in the industries has long been recognized there, much more clearly than in any other country, and the scientific method has become established in the factories, much to their advantage. Men deeply versed in pure chemistry, whose minds have been clarified by training in the university laboratories, are eagerly sought for in the factories. So thoroughly convinced are the Germans of the value of pure science for the industries that in the polytechnic schools the plan of instruction in chemistry is essentially the same as in the universities, and some of the best purely scientific work is done in the laboratories of these polytechnic schools. We, in this country, have yet to learn the importance of this relation between science and industry, though undoubtedly some progress has been made in this line. We still endeavor to make iron and steel chemists, and soap chemists, and sugar chemists, and turn out hosts of raw products that are not worth their salt. Training along such narrow lines is a positive injury to the students. They are the victims of false pretenses. Let the training be as broad as possible and as thorough as possible, and the student will at least not be crippled when he ought to be strengthened.

Finally, a few words in regard to what is commonly and properly spoken of as the highest work of the university laboratory—the training of teachers and investigators. Here, again, we find that Germany leads the world, and to her we must look for guidance; and, as is well known, to her we have looked for guidance for many years past. Just as Liebig betook himself to Paris, and Wohler to Stockholm, so in turn Americans have betaken themselves to Germany to work with the great masters. This movement began soon after the establishment of the Giessen laboratory, and many an American obtained his inspiration in that laboratory. There are living to-day a number of American chemists who sat at Liebig's feet; a still larger number look back with pride to the time spent in the Gottingen laboratory, where Wohler's was for many years the master mind. Bunsen and Hofmann attracted large numbers in their best days; and now Bayer in Munich, Ostwald in Leipsic, Victor Meyer in Heidelberg, and Fischer in Berlin, appear to exert the strongest influence upon American students. Most of the chemists holding prominent places in this country have had more or less prolonged training in German universities, and it is not to be wondered at, therefore, that German methods have found their way into our laboratories. Indeed, there are some who appear to hold that, unless a method has a German tag on it, it is not worth considering. These hold, also, that the goal to strive for is the development of a laboratory like the best in Germany.

For many years Americans have been returning to this country after having enjoyed the best opportunities afforded abroad. Each annual crop have at least one thought in common, and that is, that chemistry in this country is in a deplorable condition, and that their labors are needed to bring about a reform. These young reformers are, of course, quite out of joint with the country, and often render themselves incapable of bringing about the results they desire, by refusing to recognize what is good and endeavoring to build upon that. The true and efficient reformer is a believer in continuity. Progress has always been by easy stages. The history of chemistry in this country shows that there has been a slow and steady advancement, and there is much promise in the present.

We owe to Germany very largely the investigating tendency which is showing itself more and more every year, and while even now the amount of original work done, as compared with that done abroad, is small, it is quite natural that it should be so.

A large part of the experimental work in Germany is done by advanced students and young chemists who are waiting for positions. It is by the aid of the former class especially that the professors work out their problems. Now, the number of advanced students of chemistry in this country is much smaller than in Germany, and the same is true even to a still greater degree of young chemists waiting for positions. Increase the number of these two classes here, and the amount of investigating work will be increased accordingly. But such increase must be determined largely by the demand, and the demand for thoroughly trained chemists is by no means as large as in Germany. The most important reason for this has already been spoken of. The value of these thoroughly trained chemists in the industries has not yet been generally recognized. Indeed, those particular industries in which the aid of scientific chemists is specially needed do not exist to any great extent, so that there is very little demand for such men. Most of the advanced students are looking forward to teaching, and the graduate departments in our universities must for years to come look to these men for re enforcement. Plainly, the number of such students must be comparatively limited, or the supply will exceed the demand. After completing their regular courses these students must secure occupation. The "bread and butter question" is involved. But the number of places to be filled is limited, and every year young men well fitted to take good places are left, at least for a time, without means of support, and all their efforts must go to securing positions; and, further, when they secure their places, the conditions are for the most part unfavorable to the carrying on of higher work, and although many of them struggle manfully for a time to keep up their enthusiasm, it gradually dies out for want of nourishment.

All this is discouraging, of course, to the advanced students of chemistry, and to those who wish to study chemistry, and thus the number is necessarily kept down. It is a fair question whether the number of graduates now studying chemistry is not unnaturally large. However this may be, it is clear that, as the amount of investigating work depends upon the number of advanced students, the amount of this work must of necessity be comparatively small. More could be done, no doubt, by teachers in colleges throughout the land, and the amount done by these teachers is increasing year by year, but it is difficult for them to secure co-workers, and with unaided hands the amount of chemical work that can be done by an individual is small.

Some of the most active workers in Germany are, as has been remarked, the young chemists, who are waiting for positions. These form a comparatively large class of picked men—men who have a strong tendency to investigation, and in some way see their way clear to at least a sufficient income to "keep body and soul together." Most of them have a hard struggle, though, on the other hand, some are men of means, whose ambition is not destroyed by the fact that they have fortunes. These men, of course, are desirous of securing advancement, and they know that their only chance lies in doing good work. It is the tremendous competition among these men that leads to the results for which Germany is famed.

Very well, you will say, if that is the secret, let us have that system here But that is the very thing we cannot get. We may be able to secure a few able professors, a number of bright advanced students, good laboratories, and supplies, but this intermediate class of active workers cannot be secured, save under conditions that do not exist here, and are not likely to exist here for many years to come. Abroad the university career is one of the most attractive open to men; a professor is a very much respected member of the community, and his life is an unusually pleasant one. Without entering into a detailed comparison between the university career in this country and abroad, we may accept the general statement that this career exerts a much stronger attraction upon students there than here. Then, too, the opportunities in other fields are more limited there, so that these two forces working together lead a number of the ablest young men to choose the university career, and to face the great difficulties which they know they will have to overcome before they attain success. The first condition of that success is good work done. There is absolutely no chance for one who does not carry on investigation, nor for one who is lukewarm in his work. The school is a merciless one, but the results probably justify the means.

What possibility is there of introducing this system in this country? Let the experiment be tried. Offer young men of ability the privilege of teaching in a university and nothing else, and how many, think you, will avail themselves of it? Or if some few exceptional men under most exceptional conditions should do so, how long will they remain in the position? To keep them it will be necessary to pay them at least enough to live on, and then the very soul of the German system is destroyed. In short, we have our own problems to work out under conditions that we cannot control, and while we may be inclined to regret that we cannot have all that we should like to have; while we in this generation at least must necessarily be content to do with less scientific work than those who have breathed the German atmosphere have been accustomed to, there is pleasure in working out new educational problems, and there is satisfaction in causing the tree of knowledge to grow where before it languished. We have a great field to cultivate. It is fertile. Labor expended upon it will yield rich harvests. So let us to work. These who have been in the chemical field for years welcome the new workers, and especially such a body of workers as has been brought together in this university. May the great activity in chemical work which has characterized this university during its short life continue unabated. The Kent Chemical Laboratory is already known of all the world, even before its doors are open. May its fame increase year by year.

THE VELOCITY OF COMBUSTION OF GUNPOWDER AND SMOKELESS POWDERS.

MANY years ago Mons. De Saint Robert carried out some curious experiments with gunpowder, with the view of determining the velocity of its combustion. Briefly, his method was to fill a leaden tube with powder, and cut it into equal lengths; these lengths were then burned at various heights above the level of the sea. From the observations made, it was concluded that the velocity of combustion of gunpowder varied directly as the two-thirds of the pressure of the surrounding medium. Captain Castan has verified the increase of velocity of combustion with pressure by means of experiments with a tube containing powder. The tube was punctured with a hole for the escape of the gas, and by changing the size of this hole the pressure within the tube could be varied. Lieut. Glennon has now arrived at a formula by means of purely mathematical analysis which shows a close agreement with the results of De Saint Robert's experiments. This formula is—

$$V = K P^{\frac{2}{3}},$$

where V is the velocity of combustion, K a constant, and P the pressure of the gaseous surrounding medium outside the issuing stream of combustion gases. When the powder is burst in guns, the formula

$$V = KP^{\frac{1}{2}}$$

is a sufficient approximation to truth. Expressed in words, the principle involved in the equation is the following, viz., the velocity of combustion of gunpowder varies as the square root of the pressure of the surrounding medium. This principle is due to Mons. Sarrau. For smokeless powders, and for other explosives leaving no residue, in process of combustion as distinguished from detonation, the above equations should hold with exactness.—*Arms and Explosives.*

PALLADIUM.

DETERMINATION OF ITS ATOMIC WEIGHT—USES OF PALLADIUM CHLORIDE.

RECENT numbers of the *American Chemical Journal* contain reports of important experiments with palladium and some of its compounds.

The atomic weight of this metal has not yet been agreed upon, and the investigation of the subject by Edward H. Keiser and Mary B. Breed is given in detail. They have used palladammonium chloride as the compound most convenient for the determination of the atomic weight of the metal.

This was prepared from palladium dichloride, which cannot be used itself for the determination, on account of its deliquescence and the fact that the dichloride is partly changed into monochloride when melted. The dichloride, which had been several times distilled, was dissolved in distilled water, slightly acidulated with hydrochloric acid. Ammonia was slowly added and the solution was warmed over a water bath until the precipitate was dissolved. The solution was filtered, diluted with considerable water and had a current of pure hydrochloric acid passed into it. The precipitate thus formed was palladammonium chloride. It was thoroughly washed, then dissolved in dilute ammonia and again precipitated with hydrochloric acid gas. After being washed and dried in desiccators it was ready for use.

The compound was weighed in platinum boats. It was dried in an air bath at a temperature of 110° to 120°. The boat was then put into a combustion tube and a current of hydrogen which had been purified was passed over it. Three drying substances for the hydrogen were used: First, it was passed over solid caustic potash; next, over red-hot metallic copper; and lastly, phosphorus pentoxide. After the hydrogen, thus carefully prepared, had been passing through the combustion tube long enough for all the air to be expelled, the part of the tube holding the boat with the palladammonium chloride in it was gently heated. The chloride united with the hydrogen slowly. As the temperature is gradually raised, the ammonium chloride forms a snow-like sublimate. "There was absolutely no loss of palladium by volatilization nor decrepitation, as was shown by a careful examination of the aqueous and acid washings of the tube after the reduction was finished."

Five tests made to determine the atomic weight of the palladium, from the analysis of the palladammonium chloride, gave it as 106·246.

For the purpose of insuring accuracy, the experimenters purified some palladium in the wet way. Fifteen grains of palladium foil was dissolved in *aqua regia* and the dichloride thus obtained was evaporated to dryness. The residue was then dissolved in water slightly acidulated with hydrochloric acid, the filtered solution was treated with ammonia, and heated over a water bath until the precipitate was dissolved. The insoluble residue which contained iron and other impurities was filtered off; copper in the filtrate gave it a pale bluish-green color.

Very strong hydrochloric acid was then passed into the solution. Palladium diammonium chloride was thus precipitated. This was carefully washed by decantation and then on a filter with a suction pump and afterward dissolved again in very dilute ammonia. After repeating these processes of precipitation and solution five times, the rhodium, iron and copper were all removed. The salt was dried in desiccators and the metal was obtained by the use of hydrogen, as in the first experiment. Its purity was carefully tested, the small quantity of mercury detected was removed.

Analysis of the compound thus prepared gave for the atomic weight of palladium 106·245, a result differing only 0·001 from that obtained by the first experiment.

It has been found that palladium chloride may be used as a reagent to detect free hydrogen in mixtures of gases. It is so delicate a test that nitrogen containing $\frac{1}{20}$ of 1 per cent. of free hydrogen will show its presence when passed over the palladium chloride into a solution of silver nitrate.

If air which contains any hydrocarbon (paraffine, olefine or acetylene) be passed over slightly heated palladium chloride, it is decomposed, hydrogen chloride being set free. If the temperature of the palladium chloride is not raised above 50° C., $\frac{1}{15}$ of 1 per cent. of hydrogen in the air can be detected.

If palladium is oxidized by being heated in the air, it can be at once reduced by passing free hydrogen over it. Iridium dioxide is reduced to a metal if brought in contact with free hydrogen. This will take place in the cold and is attended with brilliant scintillations.

Mr. Francis Phillips, from whose paper these results of his experiments are gathered, says; "In point of

delicacy the palladium chloride reaction is superior to all others. Experiments are now in hand with a view to the utilization of this reaction for the quantitative determination of hydrogen."

Certainly no more valuable result of this investigation has been reached than that palladium chloride is the best reagent for the detection of carbon monoxide. Very small quantities of the monoxide in the air will cause the precipitation of metallic palladium from a solution of palladium chloride. The precipitate often forms a dark brown, lustrous metallic film on the glass. It is necessary to identify the carbon monoxide by lime water or some other test for carbon dioxide, which is formed by the action of the palladium chloride, lest the monoxide be mistaken for some member of the olefine group. The air which is being tested may be made to pass through the palladium chloride solution and then into lime water. The well known tendency of carbon monoxide to oxidize to the dioxide (which is not the case with the olefines, at a temperature of 100° or below) is a simple means for distinguishing between them. Platinum chloride may also be used for the recognition of carbon monoxide; the metal is not precipitated until the solution has been exposed to the gas several days.

PLANT LIFE IN THE OCEAN.

WHEN we speak of plant life of the deep seas, we understand by the term only very small specimens of vegetable life of the simplest form, of which there is a most astonishing variety. The Kiel Plankton expedition has taught us that the sea is filled with such an immense number of microscopic representatives of the

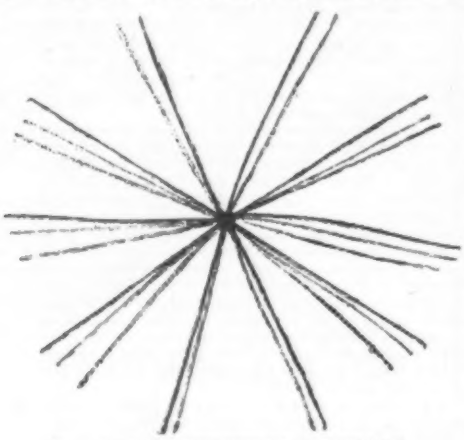


FIG. 1.—CHAETOCERAS BOREALE.

vegetable kingdom that the number of organic substances derived from them is nearly equal to that produced from plants on a land surface of equal size; and as the lower animals that serve as food for the larger and more highly organized creatures live almost exclusively on this abundant plant growth that increases so rapidly, it will be easy to understand the importance of the latter for the whole of Nature's housekeeping.

By far the greater part of the deep sea plants are siliceous algæ or diatomaceæ. Each such diatom is an individual that consists of only a single cell; which translated into popular language means that each siliceous alga corresponds to one of those billions of elementary bodies of which the organisms of all higher plants and animals are composed. In each diatom we have a plasm-mass that resembles the white of an egg, and a membrane that surrounds it, which, as in all plant cells, consists of cellulose, and in addition to these there is a case of silex, which forms a complete armor. These armor-like cases of the different genera present most varied and delicate forms, a study of which is most attractive even for the amateur microscopist, but only by the most careful observation can we find out the secrets of the siliceous algæ, the structure of which is varied according to the nature and needs of the individual diatom.

The covering of silex always consists of two similar

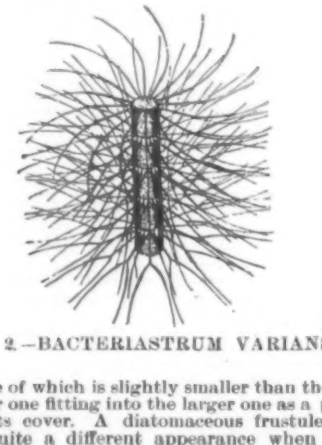


FIG. 2.—BACTERIASTRUM VARIANS.

valves, one of which is slightly smaller than the other, the smaller one fitting into the larger one as a pill box fits into its cover. A diatomaceous frustule or cell presents quite a different appearance when viewed from the front, in which case the connecting rim or hoop is seen, or from the side, when the valve is presented to the observer. Inside of this wonderfully made armor we find the living and assimilating plasm body, that is, a little viscous substance which is either spread on the inner walls of the frustule or entirely fills it.

All bodies of water are more or less rich in diatomaceæ, and we often find rare specimens in an unpretentious pond or pool, but the classes found in fresh water are very different from those in salt water, and there is even a difference between those of the coast and those of the deep sea. While a majority of the former have a casing formed of two similar valves joined at the middle by a thickened portion, the diatomaceæ of the ocean are not provided with casings arranged in this manner, but the reason for this difference is easily understood when we examine this thickened portion under a microscope, for then we see that it is provided with a narrow slit by means of which the interior of the cell is brought into communication with the exterior world. Very careful examination of the larger species of the diatomaceæ has proved that a very

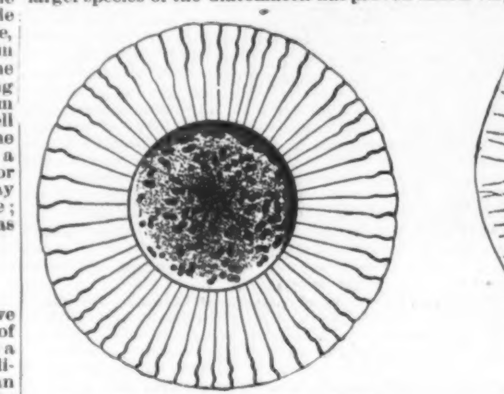


FIG. 3.—PLANKTONIELLA SOL.

fine fold of the plasm mass protrudes from this longitudinal slit, which enables the alga to fasten itself to its support, and also explains the slow, gliding motion that we have noticed in many diatoms. The diatomaceæ of the deep seas have no such individual movement, and therefore they do not need such an arrangement as that just described, but are provided with means for keeping them afloat in the water. In fact, they are admirably fitted for their conditions of life. By comparing the numerous species of ocean algæ it will be seen that they possess peculiarities by which the specific gravity of their frustules is made to very nearly approach that of the surrounding water. In an especially large species (Anteminellia gigas), which might be called the giant of ocean diatomaceæ, the buoyancy is due to an enlargement of the entire surface of the armor. This extraordinarily large diatom is drum-shaped, having a large cross section, and it is thereby prevented from sinking into deep water. They cannot live when deprived of light.

In other species, as, for example, the Chaetoceras (Fig. 1), there are horn-like or needle-like growths on the cell, and also enlargements of the upper surface, which, however, extend only in the direction of one dimension, length. In the Bacteriastrum (Fig. 2), in

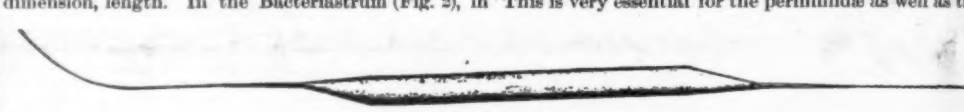


FIG. 4.—RHIZOSOLENIA SEMISPINA.

which the cells form a stiff, straight chain, such needle-like appendages are wound around the entire circumference of the siliceous casing, which not only give them buoyancy, but also serve as a protection from enemies which might find it a dainty morsel of food. The species named in honor of a former Prussian minister of education, etc. (Gossleriella tropica), is disk-shaped, and is provided with a thick wreath of thorns of a most decorative form. In the Planktoniella sol (Fig. 3) the girdle itself forms a hollow, flat wing which surrounds the circular frustule like the rim of a plate. These appendages which keep the frustules afloat remind one strongly of the wings with which many seeds of plants are provided for the purpose of keeping them floating in the air as long as possible, so that the wind can carry them a long distance. The seeds of the elm are formed in this way; they consist of a light wing or plate, the object of which is to increase the resistance offered to the wind, and the real seed is in the center of this plate.

But these types do not, by any means, exhaust the

FIG. 5.—PYXILLA BALTICA.

means for imparting buoyancy to the diatomaceæ. Let us glance at the Rhizosolenia genus (Fig. 4), and we find a simple rod-shaped frustule, the ends of which terminate in long, thin extensions that give it buoyancy. At first sight it would seem that these stiff, sharp appendages would have just the opposite effect, causing the frustule to sink quickly whenever the equilibrium of its contents was disturbed, for they would cut the water easily. This danger is prevented, however, by the arrangement of the long appendages, which do not extend in the direction of the axis of the frustule, but one is attached below and the other above the middle line, so that one always brings the other back into a horizontal position whenever the equilibrium of the frustule is disturbed. In exploring the waters of the Great Ploen Lake I was fortunate enough to find the Rhizosolenia genus in fresh water.

Another means of preventing the sinking of the rod-shaped frustule, or chains of them, consists in the curving of the separate cells or of the chains. Both of these formations occur in the Pyxilla baltica (Fig. 5), a species of algæ often found in the Baltic Sea. A bent frustule or a chain of them would always have the tendency to hold itself with the concave side up and the convex side down. The buoyancy is greatly increased thereby, the possibility of sinking being reduced to a minimum—provided always that the specific gravity of the frustules is nearly the same as

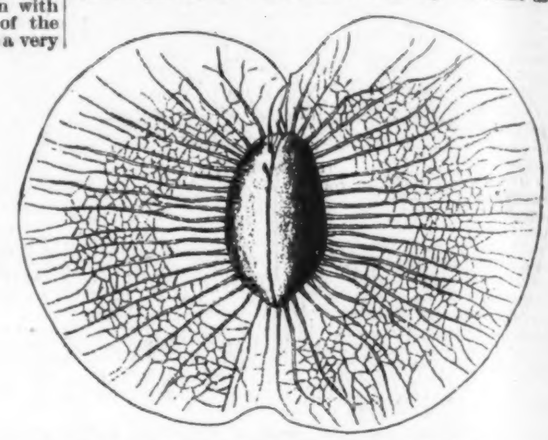


FIG. 6.—ORNITHOCERCUS SPLENDIDUS.

that of the water. The credit of having discovered these interesting facts in connection with microscopic plant life belongs to the botanist, Dr. Franz Schutt, a member of the Plankton expedition, undertaken by Prof. V. Hensen, in 1889.

The second main group of the plants of the deep seas is that of the peridiniidæ. Among these are also found single-celled, armored algæ, but the cell is not coated with silica; the casing usually consists of cellulose plates. The best way to obtain an idea of an organism of this kind is to think of a representative of the genus Ceratium, a tiny body that has exactly the shape of a two-armed anchor. Where the arms join the shank of the anchor there is a flat protuberance which contains the living portion of the cell.

The peridiniidæ differ from the diatomaceæ in possessing the means of active movement; being provided with two long flagella, which they can swing about like whips. Some of the peridiniidæ have most remarkable shapes, but these peculiarities of form are comprehensible when we keep in mind the fact that all of these grotesque lengthenings and wing-like broadenings of the frustule represent floating apparatus for holding the plant on the surface of the water. This is very essential for the perininiidæ as well as the diatomaceæ, for only in the light can they live and perform their proper functions.

Fig. 6 shows the Ornithocercus splendidus, one of the peridiniidæ that is provided with large side flaps which keep it afloat in the upper strata of the water.

Besides the two groups of deep sea plants just described, there are also bacteria and other growths of the ocean. These, however, are not nearly as numerous and are not of the same biological importance as the others.

The work of the Plankton expedition has proved that the real home of the diatomaceæ and the peridiniidæ is in cold waters. In the North and Baltic Seas, and also in the northern part of the Atlantic Ocean, the latter are abundant; at certain times of the year they are so numerous in the Baltic Sea that the other marine plants are of no more importance than the weeds in a well kept field of grain. In the warm waters inside of the Gulf Stream the plants of these two groups decrease toward the south until they form a very insignificant part of the animal and vegetable material floating on the ocean. — *Illustrirte Zeitung.*

[FROM KNOWLEDGE.]

THE MAILED MONSTERS OF ARGENTINA.

By R. LYDEKKER, B.A.Cantab.

AMONG all the extinct mammals of the Argentine, none strike the beholder with more astonishment than those gigantic cousins of the modern armadillos of South America, collectively known as glyptodonts; their name being derived from the peculiar sculpture with which the grinding surfaces of their molar teeth are ornamented. In a previous article, entitled "Armadillos and Aard Varks," we have already considered the leading characters of the great order of edentate mammals, of which the whole of the typical representatives are characteristic of South America, although a few of the extinct species wandered into North America during the Pleistocene period. We have likewise pointed out how the armadillos and their allies

differ from the other members of the order, and have likewise made some mention of the glyptodonts themselves. There are, however, such great differences between the various kinds of glyptodonts, which are sub-divided into several genera, that the group will well repay special investigation; and, indeed, no adequate conception of the extinct fauna of the "Land of Skeletons" could be given without devoting a separate article to these most curious animals.

As we have already pointed out elsewhere, both armadillos and glyptodonts differ from the other members of the order to which they belong in having their bodies protected by a bony shell or carapace, covering all but the under parts; the top of the head being covered by a similar bony shield, while the tail is incased in a series of bony rings, or in rings at the base and a long tube at the tip. Whereas, however, the armadillos (exclusive of the aberrant pichiciago, described in the article referred to) have a larger or smaller portion of the middle region of the carapace formed of movable transverse bands of plates, in the glyptodonts the whole structure is welded into a single piece. It must not, however, be supposed that this carapace consists of a single solid dome of bone, as, if it did, there would, of course, be no possibility of growth. On the contrary, the carapace, as shown in the beautiful figure taken from a photograph of the external skeleton of the largest member of the group preserved in the museum at La Plata, is composed of a number of polygonal or rhomboidal plates articulating together at their edges, and thus allowing of free growth. In very old individuals a considerable number of these plates may, however, become completely fused together. During life these bony plates were covered with small horny shields, as in the living armadillos; and they frequently show incised lines formed by the lines of union between such shields. For instance, in the members of the typical genus of the group, or ring-tailed glyptodonts, each bony plate was smooth and polygonal in shape, while the lines indicating the borders of the horny shields take the form of a rosette. Another important point of difference from the armadillos is to be found in the contour of the skull, which is short, deep, and rounded, instead of being long, flattened, and pointed at the muzzle. Then again, whereas the armadillos have small cylindrical teeth, those of the glyptodonts are large, and fluted at the sides, with their grinding surfaces marked by the aforesaid sculpture; while the whole series is in close contact, and forms one of the most efficient grinding machines imaginable. To support the enormous weight of the carapace, which in some of the larger kinds is considerably more than an inch in thickness, special modifications are needed in the internal skeleton. Here we find, for instance, as shown in the foregoing figure, that nearly the whole of the vertebræ are welded together, so that a large portion of the backbone forms a continuous solid tube. The vertebræ of the neck are also very short, and may be partially united, so that the movements of the head must have been somewhat limited. The reader will not fail to notice also the great strength and upright position of the haunch bones, and the powerful build of the legs and feet; the latter terminating in five toes, armed with broad flattened nails. As an illustration of the various modifications of the same general plan of structure in use in the animal kingdom, it may be well to point out how essentially the arrangement of the armor of a glyptodont differs from that of an ordinary tortise or turtle. In the latter the carapace is completely welded to the ribs, which are situated externally to the haunch and shoulder bones; whereas in a glyptodont there is no sort of connection between the carapace and the ribs, while the latter are internal to the haunch and shoulder bones. In these respects the leathery turtle holds a somewhat intermediate position between ordinary turtles and the glyptodonts, the carapace being composed of polygonal plates totally unconnected with the ribs, while the latter are situated externally to the bones of the shoulder and haunch.

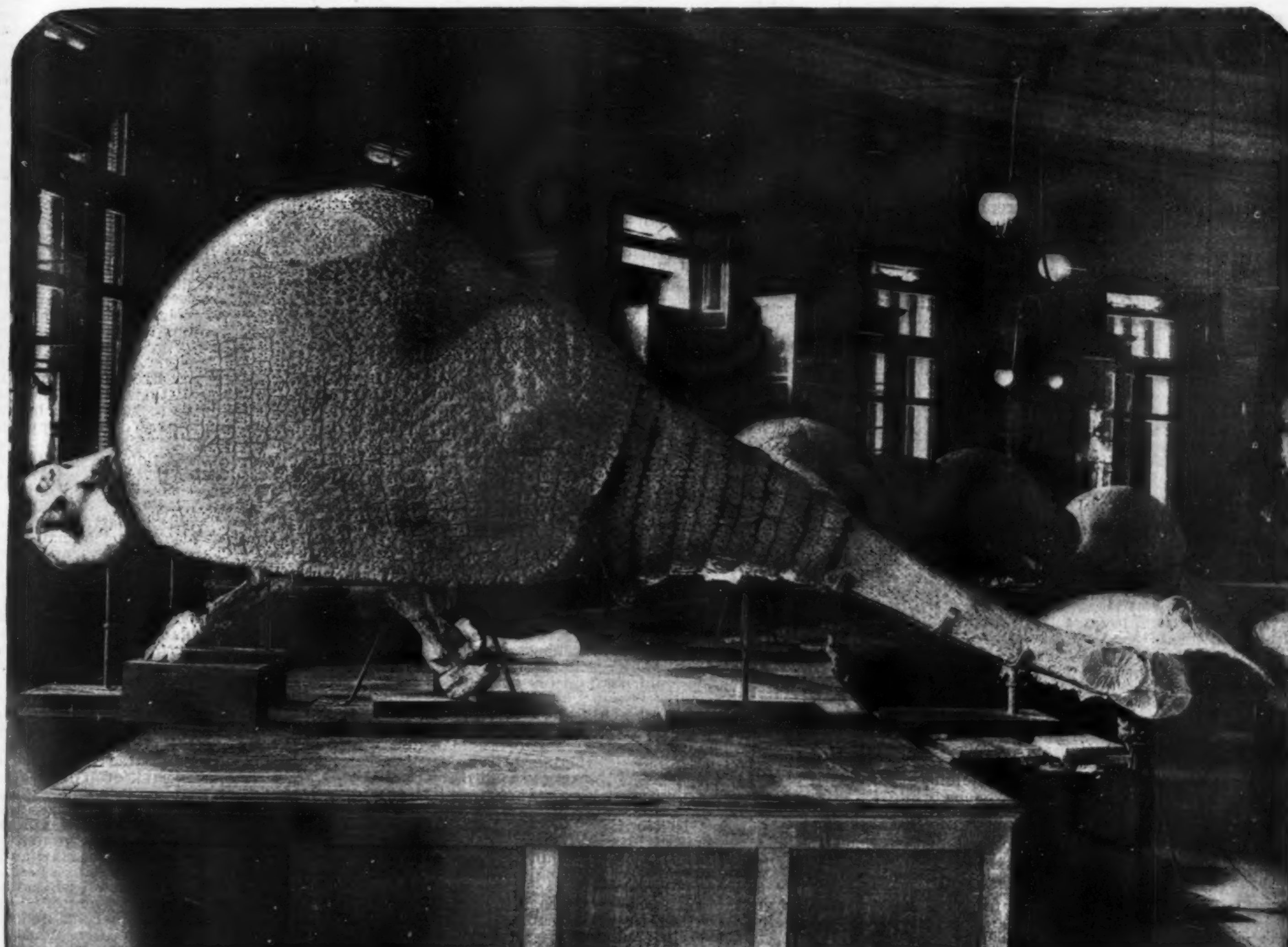
Not less remarkable are the modifications of the vertebræ of the tail for the support of the rings or tube with which the latter is incased. In the first place, most of the vertebræ of this region are welded together so as to form a hollow tapering rod; while from each segment are given off radiating processes upon which the bony plates are borne, and as the whole of the latter are firmly welded together, the entire structure is of great strength.

When standing with the edges of its impenetrable carapace resting on the ground, its mail-crowned head partially withdrawn within the front aperture of its shell, and only the lower portions of the limbs exposed, a glyptodont must have been safe from all foes save savage man, and even he must have had a tough job to slaughter the monster, if indeed he ever succeeded in doing so. That man did exist with the later glyptodonts, or those which flourished during the deposition of the Pampean mud, is, however, proved by more than one kind of evidence. For instance, crude drawings of these animals have been found incised on some of the rock surfaces of Patagonia, while in other cases human implements have been disinterred side by side with the bones and shells. Probably the empty carapaces of the larger members of the group were employed by the primitive inhabitants of Argentina as huts, and it is said that they are sometimes even so used at the present day by the Indians. That these animals were not killed off by any living foe—either human or otherwise—may be taken for granted; and we must therefore conclude that this result was probably due to the unknown causes alluded to in the first of this series of articles as having brought about the extermination of the larger Argentine mammals. It may be well to mention that although some of the living armadillos are carnivorous, it is perfectly evident from the structure of their teeth that all the glyptodonts subsisted exclusively on a vegetable diet.

The earliest known representatives of the group occur in the older Tertiary beds of Patagonia, and may be designated pygmy glyptodonts, although they have received the uncouth name of *Propalæhoplophorus*. These creatures, which lived side by side with armadillos nearly akin to existing forms, were the dwarfs of their race, the carapace not being more than a couple of feet in length. The plates of the carapace were smooth and ornamented with a rosette-like sculpture, of which the central ring in the fore part of the shell was raised into a prominent boss. In the form of these plates, as well as in the circumstance that the tail was surrounded from base to tip with a series of knobbed rings, these pygmy glyptodonts resembled the ring-tailed glyptodonts of the pampas, of which they may accordingly be regarded as the ancestral type. In the intermediate deposits of Monte Hermoso we meet with other glyptodonts which, while much larger than those of the Patagonian beds, were generally inferior in this respect to the giants of the Pampean; some of the species being nearly allied to the small Patagonian representatives of the group, while others belong to the same genera as those found in the pampas.

Passing on to a survey of the leading types of these creatures found in the alluvial mud of the pampas, where they occur in great numbers, we may first notice the one to which the name glyptodont was originally applied. The carapace in this form is characterized by the polygonal plates being nearly smooth and marked by a rosette of incised lines, while those along the margin are raised into a series of bold knobs. In general contour the whole carapace forms a nearly regular oval dome, while the plates on the back of the head were knobbed and ridged. Although in the specimen first sent to England the tail of another species was unfortunately affixed to the carapace, it is now known that the armor of the tail took the form of a number of rings, gradually diminishing in diameter from the root to the tip, and severally ornamented with a series of conical knobs, thus forming a protective case against which little short of a steam hammer would have been of any avail.

Although one might have thought that these ring-tailed glyptodonts, as they may be conveniently termed, were sufficiently large and *bizarre* to have stood alone in the world, they were exceeded both in size and strangeness of form by the extraordinary creature of which the external skeleton is represented in the accompanying plate. In this stupendous monster, which measured upward of eleven feet eight inches in a straight line, the carapace is characterized by its peculiar hump-backed form, while its margins lack the prominent knobs characterizing those of the preceding group. On closer examination it will be found that each of the component plates of the carapace, instead of being polygonal and marked by a rosette of lines, is rhomboidal and pierced by from two to five large circular holes. From the analogy of the living hairy armadillo—known in Argentina by the name of peludo, or hairy animal—it is quite evident that during life the holes in the plates of the carapace of the extinct monster, which, by the way, may be known as the "club-tailed glyptodont," or technically as *Dædicurus*, must have formed the exits of large bristles, which were equal in diameter to a cock's quill, and were doubtless many inches in length. The whole body of the animal must, therefore, have resembled a gigantic porcupine. Still more extraordinary is the conformation of the huge tail, which had a length of about five feet. At its base this appendage was en-



THE CLUB-TAILED GLYPTODONT. (ABOUT ONE-FIFTEENTH THE SIZE OF NATURE.)

circled by about half a dozen double bony rings, nearly as large at the base as the iron hoops in the middle of an ordinary beer barrel; their component plates being pierced by the aforesaid holes for bristles. The whole of the terminal half of the tail is formed by one continuous piece of hollow bone, which, if we exclude whales, is one of the most massive bony structures in the animal kingdom, and is almost as much as a man can lift. Starting at its base in the form of a nearly cylindrical tube, this sheath rapidly expands at the sides and becomes flattened on the upper and lower surfaces, until at the tip it finally assumes the form of a depressed flattened club, which would have formed a most efficient weapon for a giant. Along the sides of its extremity this club is marked by a number of oval depressed disks, showing a sculptured pattern of ridges and grooves radiating from the center, and some of them attaining a length of six or seven inches. From the structure of their sculpture it is quite evident that during life these disks must have formed the bases of huge horns projecting at right angles to the tail, which must thus have formed a veritable *chevaux-de-frise*. If, as is quite probable these horns were as long as those of the common African rhinoceros, the tail of the dædicurus must have presented a most extraordinary appearance as it dragged on the ground behind its owner (for it is impossible to believe that any muscles could have raised such a stupendous structure). The use of these horny appendages is, however, hard indeed to divine, since the creature was amply protected by the underlying bone; and it is therefore probable that they must come under the category of ornamental appendages. Be this as it may, with its bristle-clad body and horned tail, the club-tailed glyptodont may well lay claim to the right of being the most extraordinary looking creature that ever walked this earth during the whole duration of the Tertiary period. Another species belonging to the same genus, of which the remains are found in the Tertiary beds of Monte Hermoso, is remarkable for possessing a cone-shaped aperture in the middle of the hinder part of the carapace, of which the only conceivable use is that it acted as the point of discharge of a gland.

Nearly equal in size to the Pampean representative of the preceding genus, but distinguished markedly by the characters of the skull and the more regular.y dome-like form of the carapace, is another monster from the pampas, which has been described under the name of *Panochthus*. Although the plates of the carapace have the same oblong form as in the club-tailed glyptodont, they lack any perforations for bristles, and are marked by a number of patches of minute tubercles, so that this species may be spoken of as the tuberculated glyptodont. Doubtless the carapace was covered during life by thin horny shields, although the marks of these are not generally shown on the bone; and, from the absence of bristles, the creature must have been as smooth as the small existing mulita, or three-banded armadillo. The tail was much smaller than that of the club-tailed species, consisting at the base of a number of relatively small rings, and terminating in a tube of about a yard in length. This tube lacks, however, the terminal expansion and flattening of that of the preceding form, while the large disks with which it is ornamented take the form of prominent rough bosses, which probably carried flattened horny knobs, instead of spines, during life.

The last representatives of the group to which we shall allude are much smaller species from the deposits of Monte Hermoso and the pampas, which may be known as the smooth-tailed glyptodonts, or, technically, *Hoplophorus*. In these creatures the carapace was much more elongated and depressed than in the other kinds, while it projected forward on the sides of the shoulders in a manner somewhat like that of the armadillos. The plates of the carapace show a rosette pattern, not unlike that of the ring-tailed glyptodonts, but they are still smoother, and of an irregular oblong shape. As regards the tail, this consisted at the base of a number of smooth rings, fitting into one another at their junctions like the joints of a telescope, while at the end it terminated in a slightly flattened tube ornamented with a number of small, smooth, oval disks of about an inch in diameter, interspersed with which were arranged a few much larger but equally smooth and prominent disks along the sides. These disks of all dimensions were evidently coated with smooth scales of horn during life, and, from the absence of apertures for bristles, the same smoothness doubtless characterized the carapace. The head was protected by a smooth shield of small tesselated plates, and the skull is characterized by the peculiar twisting and curvature of the bones of the nose.

In conclusion, we must not omit to mention that a strange gigantic armored creature, found commonly in the cavern deposits of Brazil, and also rarely met with in Argentina, seems to have been a kind of connecting link between the glyptodonts and the armadillos, having the carapace formed of a number of movable plates, arranged in a series of overlapping bands as in the latter, but with teeth of the type of the former. Unfortunately, however, this interesting creature, which must have been as big as a large rhinoceros, is known by such fragmentary remains that its full affinities cannot yet be determined, as we are still ignorant whether its skull approximated to the glyptodont or the armadillo type.

[Continued from SUPPLEMENT, No. 961, page 15365.]

EXTINCT MONSTERS.*

A BRIEF ACCOUNT OF SOME OF THE MOST REMARKABLE FORMS OF ANIMAL LIFE IN THE PAST HISTORY OF THE EARTH.

By STEPHEN BOWERS, A.M., Ph.D., editor of the *Fallbrook Observer*, Fellow of the Geological Society of America, Corresponding Member of the Geographic Society, Philadelphia Academy of Sciences, Member of the Philosophical Society of Great Britain, etc.

THE MAMMOTH.

WHILE the monsters that we have described in previous chapters perished many ages before man appeared on the earth, and have never been seen by him alive, the monster of which we are now about to write has been seen by man and its flesh eaten by him. That, however, was after it had been entombed for untold ages in the ice of arctic regions. The remains of the Mammoth are widely diffused over the earth. They have been found in great abundance not only in North America, but also in the frozen regions of Siberia, and indeed all over Asiatic Russia. They are found in England, Ireland, Germany, Poland, Russia, Greece, Spain, and in Africa and Asia. The science of paleontology was founded largely on the remains of the Mammoth. In an ancient Chinese work dating some 500 years B. C., the Mammoth is spoken of, and the Chinese seem to have had a knowledge of their frozen remains in arctic lands. For a long period they have obtained supplies of Mammoth tusks from northern Siberia. As far back as the tenth century an active trade has been carried on in fossil ivory. It is estimated that during the past two centuries more than two hundred pairs of fossil tusks have come into the market annually, and the localities where found are far from being exhausted. After more than forty thousand pairs have been obtained from northern regions, the traveler finds them increasing as he approaches toward the north pole. It is said that the soil of Bear Island and Liachoff Island, New Siberia, consists of sand and ice with such quantities of Mammoth remains that they appear as if they were made up of bones and tusks.

* From the author's pamphlet.

But not only have the fossil remains of the Mammoth been found all over arctic lands as far as man has penetrated, but their bodies, as we have intimated, have been found intact frozen and preserved in the ice. In the year 1800 the entire body of a Mammoth was discovered in a vast stratum of ice on the banks of the river Lena. Afterward it became disengaged from its icy matrix, and white bears, wolves, foxes and dogs fed off its flesh. It was a male and had a long mane on its neck. Six years after its discovery Mr. Adams visited the spot and found most of the carcass remaining. Polar bears and other animals had trampled the long hair into the earth, but he recovered about sixty pounds weight and brought it away, with the eyes and a portion of the skin which are preserved in the St. Petersburg museum. The skin was of a dark gray color, covered with black hair and reddish wool. The ears were covered with tufts of hair.

A young Russian engineer named Benkendorf, in the employ of his government, ascended the Indigirka in a steamer in 1846. The season was unusually warm for Siberia, and the country was flooded with water. The stream, which was greatly swollen, cut new channels in many places, melting the ice and frozen soil. In one of these newly cut channels he discovered a Mammoth in an upright position, where it had been overwhelmed probably thousands of years previously. As its head and trunk rose and fell with the surging waters he discovered that it was still fastened in the ice and frozen soil by its hind feet. The monster was secured by throwing ropes and chains over its tusks and head, and after its hind feet were released it was safely landed by the aid of more than fifty men and horses. It proved to be of gigantic size, and the whole body was in a fine state of preservation. In its stomach was found the food that had formed its last repast, which consisted of young shoots of the fir and pine, also young fir cones. On the shoulders and along the back grew stiff hairs about a foot long. The hair was dark brown and coarsely rooted. Under the outer hair there appeared everywhere a soft, warm and thick wool of a fallow brown color.

The question naturally arises, What causes operated in the extinction of these monsters? This is answered, and correctly we think, by the great naturalist Cuvier. He says the Mammoths could not possibly have lived in Siberia as that country is now; and that at the very moment when the beast was destroyed the land was suddenly converted into a glacial region. This sustains the recently developed Vailian or annular theory in accounting for their destruction. His exact words are: "C'est donc le même instant qui a fait périr les animaux, et qui a rendu glacial le pays qu'ils habitaient, cet événement a été subit, instantané, sans aucune gradation."* Glaciers were formed in olden time by the declension of annular vapors, and the downrush was sudden and overwhelming, bringing instant death to all animal life. Although this could not have occurred later than the Noachian deluge, yet many of the animals, as the Mammoth, Rhinoceros, etc., remain undecayed. Even the capillary blood vessels still retain their contents, showing that there was not the slightest decomposition or breaking down of the tissues, but the catastrophe which overwhelmed them was sudden. The climate was changed as by a stroke which congealed and sealed the land in ice, locking the Mammoth and other animals therein to repose in icy beds for ages to come. Had these animals not been frozen as soon as killed, putrefaction and decomposition must have taken place. Nothing but the downrush of snows from the earth's annular system could have done this.

The Mammoth attained immense size. Some full grown males were eighteen feet high and twenty-five feet long. The tusks were ten feet long and greatly curved. Their strength was prodigious.

THE MASTODON.

We shall probably be able to show that it has but recently become extinct, if indeed it is not still living.

The principal difference between the Mastodon and the Mammoth lies in the teeth, though there are other structural differences. The teeth of the former contain rough mammillations on the surface, and from which it derives its name—Greek, *mastos*, teat; *odons*, *odontos*, tooth. The teeth of the Mammoth are like those of existing Indian elephants, having a broad united surface with regular furrowed lines. Mastodon's teeth have been found weighing sixteen or eighteen pounds each. As many as twenty-six species of this pachyderm have been identified. It was larger than the largest existing elephant, and it was more widely diffused over the earth than the Mammoth. It has been found as far north as latitude 66°. It seems, however, to have been more adapted to the temperate zone than the latter. The two enormous tusks of the upper jaw reached a length of more than ten feet, and it also had two smaller tusks projecting from the lower jaw.

* Ossemens Fossiles, Vol. I., p. 108.

Another singular fact is that the remains of the Mastodon are found in much earlier formations than those of the Mammoth. It came into existence as early as the Miocene period, and seems to have outlived the Mammoth and was doubtless contemporaneous with early man. When its bones were discovered some two hundred years ago, they were believed to be those of giant men.

That the Mastodon was known to the North American Indians is beyond doubt. Those inhabiting this country a century ago had many traditions concerning it. Sir Henry Howorth in his work on the Mammoth and the Flood says that in 1762 the Shawnee Indians found the skeletons of five Mastodons about three miles from the Ohio River, and they reported that one of the heads had a long nose attached to it, below which was the mouth. Other discoverers report similar finds, indicating that portions of the skin and hair have been seen. Dr. Koch in an article published in the *American Journal of Science* reports the discovery of Mastodon remains in which the head and one foot were well preserved, also large pieces of the skin which looked like freshly tanned leather. Dr. Barton, of the University of Pennsylvania, reported finding with Mastodon remains a mass of vegetable matter composed of small leaves and branches, among which he recognized a species of rush still common in Virginia, and upon which the animal had fed just previous to its death.

Thomas Jefferson in his Notes on Virginia says that a delegation of Delaware Indians visited him while he was governor, during the revolutionary war, and before their departure he inquired of them concerning the bones that had been found at Great Bone Lick near the Ohio River; whereupon they related to him the traditions of their fathers, which clearly pointed to the Mastodon, and which they believed still lived in the far North. Mr. Jefferson also relates that a Mr. Stanley was taken prisoner by Tennessee Indians and was carried over the mountains west of the Missouri to a stream that ran westwardly, on the banks of which large bones occurred, and that the natives described the animal to him in a way that indicated the Mastodon or Elephant, which they said still existed toward the north.

Prof. Mather in the fourth volume of the Natural History of New York says that Mr. Stickney, who was for many years Indian agent for the tribes northwest of the Ohio, said that the Indians had traditions of living Mastodons that fed on the boughs of a species of lime tree; that they did not lie down when they slept, but leaned against trees.

Prof. John Collett, State geologist of Indiana, says a skeleton of a Mastodon was found in Fountain County in that State, in a fine state of preservation, bedded in wet peat. When the large bones were cut open the marrow was found well preserved, and was utilized by the bog cutters to "grease" their boots, and that chunks of a sperm-like substance two and a half by three inches in diameter (adipocere) occupied the place of the kidney fat of the monster. The same authority says that the skeleton of a Mastodon was found in Iroquois County, Illinois, which goes far to settle the question not only that it was a recent animal, but that it survived until the life and vegetation of to-day prevailed. A mass of fibrous bark-like material was found between the ribs filling the place of the animal's stomach. It proved to be a crushed mass of limbs and grasses similar to those which still grow in the vicinity. In the same bed were found land and fresh water shells that exist alive in that locality at the present time.

For years the Indians of Alaska have contended that animals are living in the wilds of that country which according to their description correspond with that of the Mastodon. A late number of the Juneau *Free Press* says:

The Stikeen Indians positively assert that within the last five years they have frequently seen animals which, from the descriptions given, must be Mastodons. Last spring while out hunting one of these Indians came across a series of large tracks, each the size of the bottom of a salt barrel, sunk deep in the moss. He followed the curious trail for some miles, finally coming out in full view of his game. As a class these Indians are the bravest of hunters, but the proportions of this new species of game filled the hunter with terror, and he took to swift and immediate flight. He described the creature as being as large as a post trader's store, with great, shining yellowish white tusks and a mouth large enough to swallow a man at a single gulp. He further says that the animal was undoubtedly of the same species as those whose bones and tusks lie all over that section of the country. The fact that other hunters have told of seeing these monsters browsing on the herbs up along the river gives a certain probability to the story. Over on Forty-mile Creek bones of Mastodons are quite plentiful.

Those who have claimed a high antiquity for Man have brought forward the fact that his bones and his implements of warfare have been found with the bones of the Mastodon. But instead of proving his antiquity, it simply proves the fact that the Mastodon has recently existed in North America. Both Man and the Mastodon have doubtless been contemporary within the last thousand years in the New World, and possibly are at the present time.

MONSTER BIRDS.

Among the extinct monsters whose remains lie buried in the rocks, few possessed more attractive features than the giant birds. The Moa bird, of New Zealand, stood from twelve to sixteen feet high. Its leg bone (tibia) was considerably more than three feet long, while that of a tall man is but one foot four inches in length. Large and unwieldy as it must have been, weighing several hundred pounds, it seems to have existed in large numbers. As many as fifteen species have been identified, and the bird has but recently become extinct, if indeed it is not still living in the almost inaccessible mountain regions of New Zealand. The natives retain traditions of this monster bird, and celebrate them in their songs.

A great find of the remains of the Moa occurred in New Zealand in the autumn of 1891. They are said to represent at least five hundred birds. How such a vast number perished in one spot is left only to conjecture. When living the bird carried in its crop a quantity of stones to assist in grinding its food. These stones are often found, and are called Moa heaps. We found in the crop of an ostrich a large number of

quartz pebbles, amounting to probably fifty, which we presume were used for the same purpose, and seem to be common with this class of struthious or running birds.

In Madagascar the remains of another large bird have been found, belonging to the same type. Here their eggs have been found in a good state of preservation, some of which are more than a foot in diameter and will hold over two gallons. They occur in the mud of swamps, and the natives find them by probing with long iron rods.

It is a remarkable fact that remains of giant land birds of nearly the same character have been found occupying areas widely separated. We may mention the Moa of New Zealand, the Æpyornis of Madagascar and the Dromornis of Australia. These are strictly land birds, without the ability to fly or swim, and the widely separated areas in which they are found can only be accounted for on the supposition that these regions were once united and that subsequent geological changes have covered the intervening area with seas. Even in the Eocene strata of New Mexico the remains of large wingless birds have been found. These great struthious birds seem to have begun their existence far back in the Tertiary era, and in time had a wide geographical range. Their remains are found in nearly every continent, and on many of the islands, which may indicate the vast changes that have taken place in the land surface of the globe since their advent.

A story comes from Berlin that the Ornithological Society of Germany has discovered the Moa alive on the north island of New Zealand, but at this writing it lacks confirmation.

ADDITIONAL EXTINCT FORMS.

A Monster Deer.—In late geological times there appeared in Ireland, England and the Continent a gigantic deer, popularly known as the "Irish Elk." It seems to have been more numerous in Ireland than elsewhere. Its remains are found there in great abundance. It was a veritable deer, but of enormous size. It stood twelve or fourteen feet high, and its horns measured twelve feet from tip to tip. The skull and horns weighed nearly one hundred pounds. The vertebræ of the neck were necessarily large in order to support the vast horns. It must have had a vigorous circulation, for it doubtless shed its horns annually, as do other deer, and the osseous matter of which they were composed must have been drawn from the blood and carried by arteries to the head. In the bed of an old lake, now filled with peat, more than one hundred heads of this monster were found, which indicates, to some extent, the vast numbers that once inhabited the Green Isle.

The Early Horse.—The horse cannot properly be classed among monsters, yet its early history, obtained from the leaves of the Great Stone Book, is full of interest, and may properly be noted here. The horse made its appearance in Eocene times. The earliest remains are known as Eohippus, or dawn horse. Then, in the next succeeding age, the Miocene, we have Mesohippus, and toward its close Miohippus. After this come Protohippus and Pliohippus, both in the Pliocene period, and Equus in Quaternary times. The early forms were not larger than a fox, and what is still more singular, they had in front four perfect toes and three behind. This was especially true of Orohippus. In Eohippus, or dawn horse, there are rudiments of a fifth toe. In Mesohippus the fourth toe is wanting, except a small splint bone, which is not found in Protohippus. In Pilohippus but one toe is found, which is slightly split, and a small splint bone, which is found on each side of the leg, as in the modern horse. Equus, or the recent horse, has one solid toe. In the early horse the ulna and the fibula were free, that is, they were two distinct bones, but as we ascend in the species they begin to unite, or become soldered together, and finally become one bone. It seems strange that the progenitors of the horse tribe were little larger than house cats, and had three or four or five distinct toes on each foot. But the geological record shows this to be true beyond doubt. Mesohippus and Miohippus were about the size of a sheep, and Protohippus was about the size of an ass. From these forms have been evolved the present noble animal so useful to man. The remains of forty species have been found, some of the later rivaling in size the horse of to-day.

A Strange Animal.—The Miocene and Pliocene strata of Germany, France, Greece, Asia Minor, and some other regions furnish us with the remains of a strange animal called the Dinotherium. It derives its name from the Greek, "deinos," terrible, and "therion," beast. The animal when full grown was probably eighteen or twenty feet long, and of elephantine proportions. The head alone was nearly four feet long. It had two enormous tusks in the lower jaw turning down like those of a walrus. It also had a trunk similar to the elephant. The jaws had five molar teeth on each side. The animal partook of the character of the elephant, hippopotamus, tapir, and the dugong. It probably lived in the water, or was at least amphibious. Its great curving tusks would serve not only to dig up the roots of plants at the bottoms of lakes, rivers or shallow seas, but also assist it in climbing banks to the dry land, or, as some naturalists believe, to hook into the earth on the margin of streams while its ponderous body remained in the water, and in which position the animal rested or slept.

A Monster Covered with Wool.—The Tertiary period has yielded the remains of a singular animal known as the Woolly Rhinoceros. It attained a length of twelve or more feet, with corresponding height. It supported two large horns, one on its muzzle and the second just back of the first. It was stoutly built, and must have been able to defend itself against the attacks of other animals. Doubtless the Mastodon found it no trifling foe. The body of the Woolly Rhinoceros has been found intact in the frozen soil in Siberia, where it was probably overwhelmed by a downrush of snow and ice from overcanopying vapors thousands of years ago, and has been preserved in the ice to the present day. The animal had long hair or wool, which formed a complete covering for its body and legs, and even its feet. The skin itself was smooth, and did not lie in folds or wrinkles, as is common with the modern Rhinoceros.

Ancient Whales.—In the Eocene period a large cetacean made its appearance in vast numbers. It was between the Whale and the Seal in its relations. The teeth were yoke-like in appearance, from which the animal derived its name, Zeuglodon—Greek, "zeugle," yoke, and "odont," tooth—being apparently yoked in pairs. It attained a length of seventy or eighty feet, with vertebræ a foot or more in diameter. Their remains are found in some of the Southern States. In places its bones are so numerous that they have been used to construct fences. It would seem that vast numbers had been stranded by some great tidal wave, or other cause, on the shores of the Mexican Gulf. This great whale-like monster probably disappeared before the close of the Miocene period.

The Early Fishes.—The first Fishes made their appearance near the close of the Upper Silurian age. But they were generally quite different in appearance to those now living. In the Devonian, which was preeminently the age of Fishes, there was a fish that was covered with bony plates and swam by means of wing-like fins. Another was covered with bony plates in front, but its tail was bare and was used for locomotion. Some were covered with shields of rhomboidal plates. Others had blade-like teeth, and some had teeth like the claws of an animal, while others had mouths paved with rounded teeth like cobble stones. In these early Fishes the tail fin was vertebrated, and they possessed many characteristics of reptiles. Afterward a separation seems to have taken place, and one branch developed into true Fishes and the other into Reptiles. The first Fishes were air-breathers, and appear as the connecting link between Fishes and Reptiles. It must be confessed, however, that the Shark family known as Selachians were among the first Fishes, and differed but little from the modern Sharks known as Squalodonts. In Tertiary times huge Sharks were the chief rulers of the seas. The phosphate beds of South Carolina contain vast numbers of their remains. We have in our possession a tooth that would nearly cover an ordinary printed page. It is six inches long and five inches wide, and it is said that some are even larger. Think of a monster that could carry two or three hundred such teeth in its mouth! It probably represents a creature one hundred or more feet in length. At one time they must have been sufficiently numerous to nearly clear the seas of other forms of animal life.

A Remarkable Sirenian.—The most remarkable of the Sirenia family is what is known as Steller's Sea-cow. It was so called because it was first discovered by the German naturalist Steller, who, in company with Bering, a captain of the Russian navy, with his vessel and crew, was cast away on Bering Island, where the latter died in 1741. Steller saw it alive during his long enforced residence on the island, and became familar with its habits. He says the Sea-cows fed in the shallow water along the shore, and collected in herds like cattle. They ate the seaweeds that grew there, raising their heads above the water every few minutes to obtain fresh air. They were slow in their movements and mild and inoffensive in disposition. In color they were dark brown, sometimes spotted, and when full grown reached a length of thirty-five feet. They seemed much attached to each other, and when one was harpooned the others tried to rescue it. In Steller's time the animal was limited to two islands, and seems to have entirely disappeared about 1780. They were exterminated for their flesh and hides. The body was very large, requiring forty men to drag it from the water. Sirenian remains have been found from the Eocene period to the present time.

FOREGLOWS AND AFTERGLOWS.

By Dr. J. G. McPherson, F.R.S.E.

Men do not wonder at the adoration by the savage of the sun; for to the untutored mind the majesty of that orb eclipses all. Among created things the sun is likest a god, shedding, on its way of glory, beauty, life and joy in unlimited profusion. To the eye of the artist nothing in nature can compare to a sunrise or sunset in certain seasons. And to educated theists the sun is the

"Creator's crest upon His azure shield the heavens."

By the sun's benignant beams of light and heat the earth rejoices to-day, as it has ever done since, by the divine *fiat*, it became the center of our system. The world's unwithered countenance is bright as at creation's day. The sun is always the joy-inspiring element in nature—the source of the rainbow colors on the dark cloud. And no man has more beautifully described the sun than did the poet king of Israel in those oft-admired words: "The sun, which is as a bridegroom coming out of his chamber, and rejoiceth as a strong man to run a race. His going forth is from the end of the heaven, and his circuit unto the ends of it; and there is nothing hid from the heat thereof."

This suggests sunrise. The powerful king of day rejoices as he steps upon the earth over the dewy mountain tops, bathing all in light and spreading gladness and deep joy before him. The lessening cloud, the kindling azure and the mountain's brow, illumined with golden streaks, mark his approach; he is encompassed with bright beams as he throws his unutterable love upon the clouds, "the beauteous robes of heaven." Soon he touches the green leaves all a-tremble with gold light. Aslant the dew-bright earth and colored air he looks in boundless majesty abroad, lightening the rocks and hills and streams that gleam from afar. From universal gloom—horribly pictured by Byron in "Darkness"—he clothes all in bright beauty, proving himself to be "of all material beings first and best." Yet the material glory is infinitely intensified when it is clothed in light by the imagination and irradiated by the poetic spirit. Over Christopher North's soul a gorgeous sunrise had ever an enchanting spell. And to the poetic mind of the philosophic genius, Prof. Ferrier, the changing colors of sunrise suggested a very apt illustration of the dark theory of the "Becoming," as laid down in mere skeleton form by the Greek philosopher Heraclitus. The dawn steals gradually over the earth and sky; and never at any moment can we say that the degree of light and color is definite and fixed. It is continually changing. It is continually becoming stronger and stronger; and yet at no instant can we say or think: here one degree of clearness or color ends, and here a higher degree of clearness or color begins. In truth, none of the changes have either any end or any beginning, so imperceptibly are they run away into each other. The reason tells the eye that, even for the shortest time that can be named or conceived, the observer never sees any abiding color, any color which truly *is*. Within the millionth part of a second the varied glory of the eastern heavens has undergone an incalculable series of mutations. The eye seems to arrest the fleeting pageant and to give it some continuance; but the reason says it is only a series of fleeting colors, no one of which *is*. As the circle is traced by a pencil moving continuously in a straight line and out of it at the same time, or as the acceleration of a falling stone is produced by the velocity being fixed and increasing at the same instant, so the gorgeous lights and colors of sunrise proceed from a blending of fixity and non-fixity. They illustrate the philosophy of the Becoming instead of the Being.

But glorious and educating and inspiring as is the sunrise in itself in many cases, there is occasionally something very remarkable that is connected with it. Rare is it, but how charming when witnessed, though till very recently it was all but unexplained. This is the *foreglow*. It is in no respects so splendid as the afterglows succeeding sunset; but because of its rarity, its beauty is enhanced. We remember a foreglow most vividly which was seen at our Strathmore Manse in January, 1893. Our bedroom window looked due west; we slept with the blind drawn. On our table was an ordinary leaf diary, with the hours of sunrise and sunset daily marked. On that morning we were struck, just after the darkness was fading away, with a slight coloring all along the western horizon. The skeleton branches of the trees stood out strangely against it. The coloring gradually increased, and the roseate hue stretched higher. The old well-known faces that we used to conjure up out of the thin blended boughs became more lifelike as the cheeks flushed. The fine old copper beech (eight feet in circumference before it breaks off into three commanding limbs), the gauzy-sprigged birches, the gnarled elms, and the holly, that alone by its green leaves showed signs of life, stood finely out against the light roseate belt of western sky. There was rare warmth on a winter morning to cheer a half despairing soul, tired out with the long hours of oil reading, and pierced to the heart by the never-ceasing rimes; yet we could not understand it. We went to the room opposite to watch the sunrise; for we had observed on the diary that the appearance of the sun would not be for a few minutes. There were streaks of light in the east above the horizon, but no color was visible. That hectic flush, slight, yet well marked, which was deepening in the western heavens, had no counterpart in the east, except the colorless light which marked the sun's near approach. As soon as the sun's rays shot up into the eastern clouds, and his orb appeared above the horizon, the western sky paled, the color left it, as if ashamed of its assumed glory. A foreglow like that we have very rarely seen; and its existence was a puzzle to us, till we studied Mr. John Aitken's explanation of the afterglows after sunset. We have never come across any of his descriptions of a foreglow, and, of course, across no explanation of the curious phenomenon. The western heavens were colored with fairly bright roseate hues, while the eastern horizon was only silvery bright before the sun rose; whereas, after the sun rose and colored the eastern hills and clouds, the western sky resumed its leaden gray and colorless appearance. Why was that? What is the explanation?

The varied phenomena attending an afterglow are capable of giving a clearer explanation of the foreglow; and to the sunset and the appearances that follow in its train we now turn. This is advisable, for during many months of the year one can witness the gorgeous afterglows, and study what we are to say in explanation; whereas it is not an easy matter to secure a good foreglow with decided varying effects. One is always struck with the resplendent brilliancy of the autumn sunsets. Some nine years ago these were exceptionally grand, and in due course something will be said about this. But for our examination of an afterglow we have selected a September day in 1893, because one could examine it more carefully with the gentler lights and colors.

A glorious sunset has always had a charm for the lover of nature's beauties. The zenith spreads its canopy of sapphire, and not a breath creeps through the rosy air. A magnificent array of clouds of numberless shapes comes smartly into view. Some, far off, are voyaging their sun-bright paths in silvery folds; others float in golden groups; some masses are embroidered with burning crimson; others are like "islands all lovely in an emerald sea." Over the glowing sky are splendid colorings. The flood of rosy light looks as if a great conflagration were below the horizon. We wended our way up to the high road between Kirriemuir and Blairgowrie to get a full view of the whole sky. The setting sun shone upon the back of certain long trailing clouds which were much nearer to the observer than a range behind; and the front of these were darkly glowing, with the fringes brilliantly golden, while the front of those behind was sparklingly bright. In the time we have taken to make these jottings the sun had disappeared over the western hills, and his place was full of spokes of living light. Looking eastward, we observed on the horizon the base of the northern limb of a beautiful rainbow, almost upright, and only a few degrees in length, produced, no doubt, by the refracted rays through the moist atmosphere in the west. Gradually it melted into thin air, and a hectic flush began to visit the eastern horizon.

Soon in the west the light faded, and piles of cold, neutral tinted cloud encanopied the semicircle of pale light. The belt of cloud above the hills, which before stood out as if brushed with liquid gold, was now chillingly dark. But out of the east there came a lovely flush, and the general sky was presently flamboyant with afterglow. The front set of clouds was darker except on the edges, the red being on the clouds behind; the horizon in the east being particularly rich with dark red hues. Ten minutes after the sun sunk, the eastern glow rose and reddened all the back clouds, but the front clouds were still gray. The effect was very fine in contrast. The fleecy clouds in the zenith became transparently light red as they stretched over to reach the silver-streaked west. But the front clouds, that were coming east by the gentle and balmy western breeze, were dark gray, without any roseate

hues. The last of the swallows were seen flying high up as if in the gauzy clouds. Close to the southern horizon there was a deep band of red unclouded sky, against which the wooded Sidlaws looked black and somber. The new moon was just appearing upright against a slightly less bright opening in the sky, which, with the shrill cry of an owl in the copse, had a mystic effect on the scene. In five minutes more the rosy coloring left the eastern horizon; but, when the clouds opened in the west, the flushed sky was then magically displayed. Again, in the north, east, and south a richly roseate belt was marked between 50° and 10° of elevation. Gradually the back clouds in the zenith (very thin) became slightly reddened, but the front clouds then were uncolored as before. As the coloring of the upper zenith clouds wandered to the west, where a flush of glowing was seen in the back clouds, the red in the east gradually waned. The varying shades of the different kinds of blue were now beautifully seen from the pale blue at the horizon to the deep azure of the zenith. Half an hour after sunset there was no red in any part except a lingering flush in the sky behind the western clouds. But, strange to say, within the next ten minutes a second glow commenced, very feeble, still discernible. The north and east warmed up slightly with a slight tinge of rosy red. Gradually the under clouds, about 50° above the western horizon, became slightly red beneath, the back ones being dark—the reverse of what was seen before. Fifty minutes after sunset the east was still slightly flushed, as was part of the open sky in the west, whereas the open sky in the southwest was of a pale bluish-green hue. Soon the colors collapsed, and the peaceful reign of the later twilight possessed the land. The temperature was 58° Fahr., far too high for a gorgeous display. (This will be afterward explained.) The grass was perfectly dry, and there were no symptoms of dew, also against brilliancy in the afterglow.

Now why was the eastern horizon so flushed with crimson when the sun had sunk in the west, and silvery light alone was seen in the opening of the sky above where the sun had disappeared? Similarly, why was it that in the foreglow that belted the western horizon there was a rich roseate color, while in the east, before sunrise, there were only light silvery streaks that indicated the sun's approach? Why should there be red colors in the least expected places—especially such an immense variety and wealth of reds? Mr. John Aitkin, F.R.S., has devoted considerable attention to this subject, both in this country and in the south of France. What we cannot so easily determine here, where the skies are so generally cloudy, and the temperature so variable, he easily discovered in sunny France; for there the different sunset effects repeat themselves evening after evening in cloudless skies and with equable climate.

Some are of opinion that the varied colors are due to an excess of water vapor in the atmosphere, the sun's rays being colored as they pass through the vapor. But he is of opinion that, though moisture in the form of vapor particles (formed by the dust particles attracting the moisture in the air) increases and intensifies the colors, yet atmospheric dust is essential for the production of the afterglows. And he was the more convinced of this by the very remarkable and beautiful sunsets which occurred ten years ago, after the tremendous eruption at Krakatoa, in the Straits of Sunda. There was then ejected an enormous quantity of fine dust. Mr. Verbreek, a high authority on the subject, computed that no less than 70,000 cubic yards of dust actually fell round the volcano itself. This will give an idea of the enormous quantity of fine dust that was showered into the atmosphere all over the world. So long as that vast amount of dust remained in the air did the sunsets and afterglows display an exceptional wealth of coloring. All observers were struck with the vividly brilliant red colors in all shades and tints. Now, if dust is the cause of these glowing colors, there must be somewhere the blue complementary coloring, seeing that the dust acts as a disperser and not an absorber of the sun's component rays. The minute particles of dust in the atmosphere arrest the rays and scatter them in all directions; they are so small, however, that they cannot arrest and scatter all; their power is limited to the perfecting of the rays at the blue end of the spectrum, while the red rays pass on unarrested. There, therefore, ought to be somewhere in the sky a display of the colors of the blue end of the spectrum; and these are found in numberless shades from the full blue in the zenith to the greenish blue near the horizon. In fact, the wonderful greenness sometimes appears in a clear space in the lower sky, more intensified when contrasted with a rose-colored cloud or haze alongside of it. Dust, then, is the main cause of the glowing colors attending sunset; for none of the colors are destroyed—only sifted out and sorted in a marvelous way. If there were no fine particles of dust in the upper strata, the sunset effect would be whiter; if there were no large particles of dust, there would be no coloring at all. If there were no dust particles in the air, the light would simply pass through into space without revealing itself, and the moment the sun disappeared there would be total darkness, as when a candle is blown out in moonless midnight. The very existence of our twilight depends on the dust in the air, and its length depends on the amount and extent of the dust particles.

We saw that soon after sunset, though the western sky was silvery, the sky near the eastern horizon was flushed with red. That is due to the sun's rays being deprived of all except the red in their passage horizontally through so much of the atmosphere, and these red rays falling on the large particles low down in the eastern heavens illuminated them with red light. This red light near the eastern horizon would be much redder if it were not for the great amount of blue light reflected by the particles from the sky overhead. But how have the particles been increased in size in the east? Because, as the sun was sinking, but before its rays failed to illumine the heavens, the temperature of the air began to fall. This cooling made the dust particles seize the water vapor to form fog particles of a larger size. The particles in the east first lose the sun's heat, and first become cool; and the rays of light are then best sifted, producing a more distinct and darker red. As the sun dipped lower the particles overhead became a turn larger, and thereby better reflected the red rays. Accordingly the roseate bands in the east spread over to the zenith and passed over to the west, producing in a few minutes a universal transformation glow. Before, however, the ruddy flush reaches the zenith, the polariscope could display the redness even then, though unseen by the unassisted eye. From this we see that the crimson, seen in the east shortly after sunset, ascends in gradually paling hues, by reason of the interference of the strong deep blue overhead, then stretches overhead on to the west, where again it becomes more golden, mixed in an aurora-like glow.

The variety in the colors and the difference of their intensity depend, too, upon the two sets of dust particles in the air. To produce the full effect often witnessed, there must be, besides the ordinary dust particles, small crystals floating in the air, which increase the reflection from their surfaces. These crystals shine far more brilliantly when suspended in the air between the observer and the sun than in any other position, and there is generally a sufficient number to produce this glorious result. The light reflected by the large quantities of ordinary kinds of dust is the chief cause of the red glow in the south, north and east; the crystals enhance the western glow effects. In winter sunsets, the winter-clad dust particles get frozen, and the red light streams with rare brilliancy, causing all reddish and colored objects to glow with a strange brightness. Dead beech leaves, which in ordinary are not noticed in a marked degree, shine out as deeply red as those of the blood-stained maple. All the red tiled roofs or red sandstone gables of the houses shine out brightly, as if painted with vermilion. When afterward we find that there has been a heavy deposit of dew, we can account, by the sudden change of temperature after sunset, for some of the brilliancy of the coloring; then the air glows with a strange light as of the northern dawn. From all this it is clear that though the coloring of sunset is produced by the direct rays of the sun, the afterglow is produced by reflection or rather radiation from the illuminated particles near the horizon.

But we can satisfy ourselves still more by another consideration that the afterglow is only a reflection of the sunset colors on the horizon by the same particles as shown by the direct sunlight before. Every one knows that daylight is far brighter than lamplight, yet it is not so easy to realize the full difference. Bring a lighted lamp into the room about sunset, without drawing down the window blind. The room does not seem to be any better lighted. One experiment was made where the window looked to the west. As the sun sinks, note how the lamp begins to light up a wider and wider area in the room, until the room seems lighted by the lamp alone, while we can still see our way about in the lawn outside. Similarly, if we keep in view the vast scale of brilliancy to be met with at sunset, we can see that what is dark at one time and under certain conditions may really appear brilliantly illuminated a short time afterward under different conditions. If a small area of the brilliantly clear western sky were projected by means of a mirror upon the eastern, the eastern, which looked bright before, would, alongside the reflection of the western, look black. A cloud on a bright sky may look black; but remove the white sky, and we find the cloud is brilliantly lighted up. No red glow is observed overhead by the naked eye, while the polariscope can detect it, so that the red must be there. When conditions change, the red becomes visible. We imagine that in the afterglow the red overhead has increased; but in reality it has decreased, for the stars are becoming more and more numerous, showing that the daylight has been decreasing all the time.

To keep the eye from being bewildered with the afterglow, let the setting sun shine into your room so as to paint an image of the window on the wall opposite. A bright orange light may be observed in the picture, while the little clouds in it are lighted up with the same hue. As the sun sinks, the color deepens in the picture, and the clouds then glow with a fine red light. After the sun ceases to shine on the clouds, their brilliancy gradually wanes, until at last they appear to be black; yet if you look out, you will find the sky in the east and overhead flushing with crimson. After a time, the clouds in the picture lose their black appearance, and their western edges again glow with a rich light, very much as at first, except that the sharp outlines have become hazy. This shows that the illumination was from the western sky, as the clouds were far too low to be lighted up by the direct rays of the sun. The hazy outlines, too, give evidence of the indirect light which illuminates them.

Without the dust particles there would be no foreglows or afterglows—no dawn, no twilight. Sudden light and sudden darkness would daily startle man and beast. There would be no coloring either in the morning or evening. The charms of sunrise and sunset would be gone. Strange that the grandeur of the heavens in sunrise foreglows and sunset afterglows depends for its existence on dust particles and water vapor!

It has long been supposed that the coloring of earth and sky at sunrise and sunset is more gorgeous when observed from the top of a mountain than at its base; but Mr. Aitken's careful and repeated observations at the Rigi Kulm (6,000 feet), in Switzerland, all point the other way. For several days he took accurate notes of the observations, and the weather was uniformly favorable; but on none of the days did he see any display of color; indeed, he was particularly struck with the want of it. Grays predominated over other colors. Now during that time, he was afterward told by trustworthy observers, the sunsets a mile below, from Lucerne, were remarkably fine for color effects. The coloring must, therefore, have been produced by the more dusty lower air. This supposition is supported by other observations. On the mountain top the near cumulus clouds were always snowy white, while it was only the distant ones that were tarnished yellow, showing that it required a great distance at that elevation to give even a slight coloring. There seems, therefore, to be very good reasons for supposing that the coloring at sunrise and sunset will be more brilliant when seen from the valley than from the mountain top.

We cannot help lingering fondly on this charming subject, just as the sun lingers in the production of the afterglows instead of suddenly finishing its work. We have to witness the sunsets at Ballahulish to be assured that Waller Paton really imitated nature in the characteristic bronze tints of his richly painted landscapes; and never can we forget the May afterglows at Bridge-of-Allan, where, recruiting after a long illness, we were spellbound by their fresh and invigorating grandeur. Then, of course, we were more susceptible to the magical power of Nature. The air was full of music. The thrush rivaled all the songsters of the grove in pouring forth, in his varied movements, his passionate love song. Oh, for the power of Richard Jefferies to put in words what we saw and felt! The trees were being clothed with their fresh foliage; the green being unscorched, the brown being unbronzed. Peace reigned supreme, and Nature reposed in rosy sleep. The full moon was shining in the east with borrowed, reflected light, for already the sun was below the horizon. The clouds were tinged with light red from the eastern horizon all over the zenith, but in the west they had more of a neutral tint; while below the rich, roseate, fairy-like light clothed all the trees with a golden sheen. And behind all there seemed to be manifested a Spirit to which our own spirit thrilled in ecstasy. Such a scene of glory must elevate the moral tone of any man who is not soulless. The conception of the Divine rises above the material phenomena to purify, to hallow, and to calm the human spirit. Then we discern that science becomes possessed of heavenly light, and "by that light really see light."

> Nature's self, which is the breath of God,
> Or His pure word by miracle revealed.

—*Gentleman's Magazine.*

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